COMMISSION OF THE EUROPEAN COMMUNITIES

AGRESTE

PROGRAMME

PT. 2

QUATERLY REPORT

DECEMBER 1975 - JANUARY 1976

PART 2

FRENCH TEST-SITES

ORIGINAL CONTAINS

COLOR ILLUSTRATIONS

The Quaterly report of the french part of the AGRESTE program presents the directions in which the different laboratories will carry out their investigations. It shows the ground-truth works at the time of the Landsat 2 passes on the rice-fields of Camargue and the ground-truth methodologic works on poplar-site. The different kinds of imagery were available on November 1975 and the first data processing in this report corresponds to the preliminary investigations.

The different chapters show the interest that the rice-field temporal mapping presents, the possibility of alluvial facies localization using infra-red color photographs, the methodology of measuring cover rate in poplar stands with a first inventory and finally the specific results concerning every kind of remote sensing on the poplar-site.

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CONTENTS

CHAPTER I

FIRST RESULTS FROM THE AGRESTE PROGRAMME

ON IRRIGATED CROPS AT FRENCH TEST-SITE n° 4

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INTRODUCTION.

The objectives of the Agreste program on irrigated cultivation (rice) in the Camargue region French test-site n° 4 (figure 1) are the following :

- to make an inventory of the total area of rice field within the test site,
- to estimate production,
- to identify plant diseases.

To date, only the first objective of the program has been studied using LANDSAT 1 imagery, since the data were insufficient to cover the growth stages of the rice during one vegetation cycle.

Research has been carried out along the following two lines :

1. Determining the necessary ground truth for interpreting the LANDSAT imagery. This work is conducted by the Station d'Amélioration des Plantes (Plant-improvement station) of the INRA in Montpellier.

2. Traitment of the LANDSAT imagery, carried out by the Centre d'Etude Spatiale des Rayonnements in Toulouse (Space radiation study center).

In this paper these two aspects will be discussed and the first results presented.

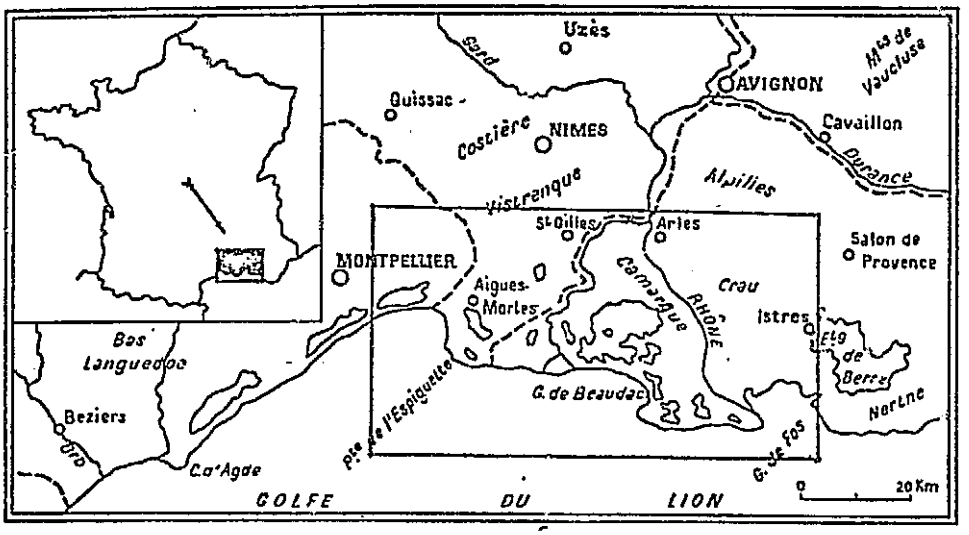

FIGURE 1

FRENCH AGRESTE TEST SITE N° 4

I - GROUND DATA DETERMINATION.

Information was collected on the state of rice fields and on climatic factors in the surrounding areas during the passages of the LANDSAT 2 satellite for the vegetation season of 1975.

The state of the rice fields is determined by ground observations which involve the stages of development of the rice for the three varieties cultivated in one parcel known as the Mas de Gouine (figure 2). These are the three most commonly cultivated rice varieties in the Camargue region, i.e., Delta, Euribé, and Balilla 28.

During the passages of LANDSAT 2, observations on the stages of development and on soil conditions were made (Table 1). The legends to the abbreviations corresponding to the stages of development are as follows :

LE : (levée) emergence
DT : (début de Tallage) : Beginning of the Tillering
DM : (début de montée) : Beginning of the Stem Elongation
GO : (gonflement visible) : Boots just visible
DE : (début d'épiaison) : Beginning of Heading
MF : (mi floraison) : Mid flowering
LA : (grain laiteux) : Early milk stage
PA : (grain pâteux) : Early dough stage
DU : (grain dur) : Caryopsis hard
FC : (fin de cycle) Caryopsis loosening in daytime.

At the same time, climatic measurements were made during the passages of LANDSAT 2 by meteorological recorders placed in an experimental rice field (the Mas d'Adrien, Figure 3) with the aid of the Service Technique d'Etude des Facteurs Climatiques de l'Environnement (SIEFCE-INRA, Montfavet) (the Environmental Climatic Factors Technical Study Service).

The measurements given in Table 2 are as follows :

1. Air temperature : recorded at 2 meters in meteorological shelter conforming to international standards. Three values are recorded over a 24-hour period : maximum, minimum, and average.

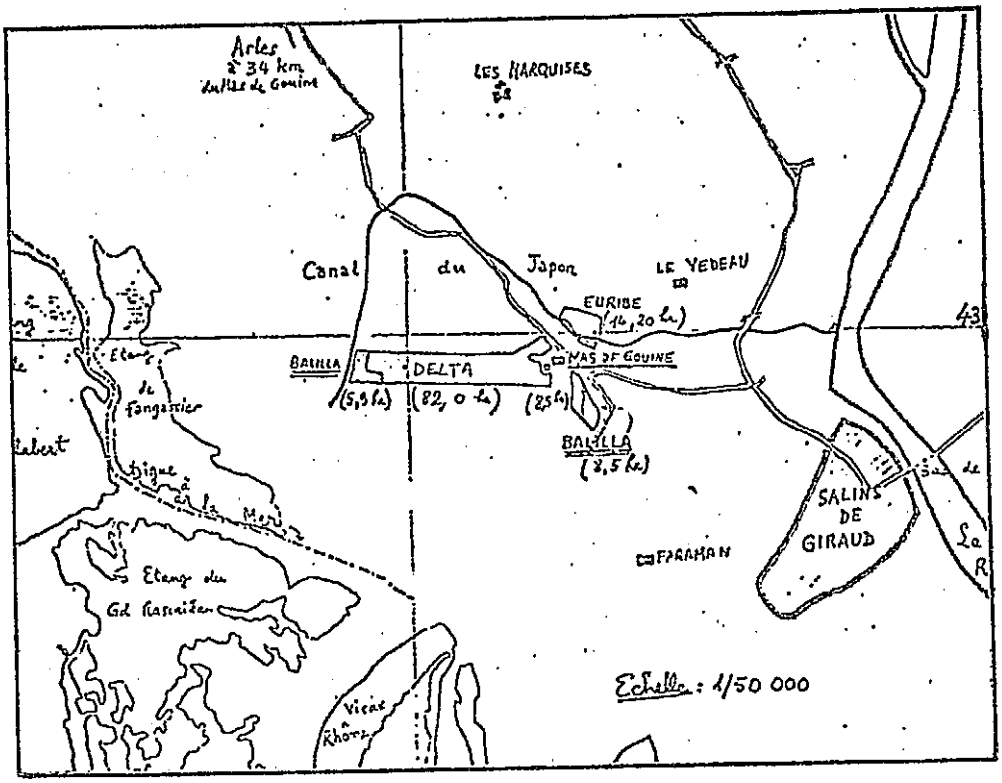

FIGURE 2

"MAS DE GOUINE"LOCATING

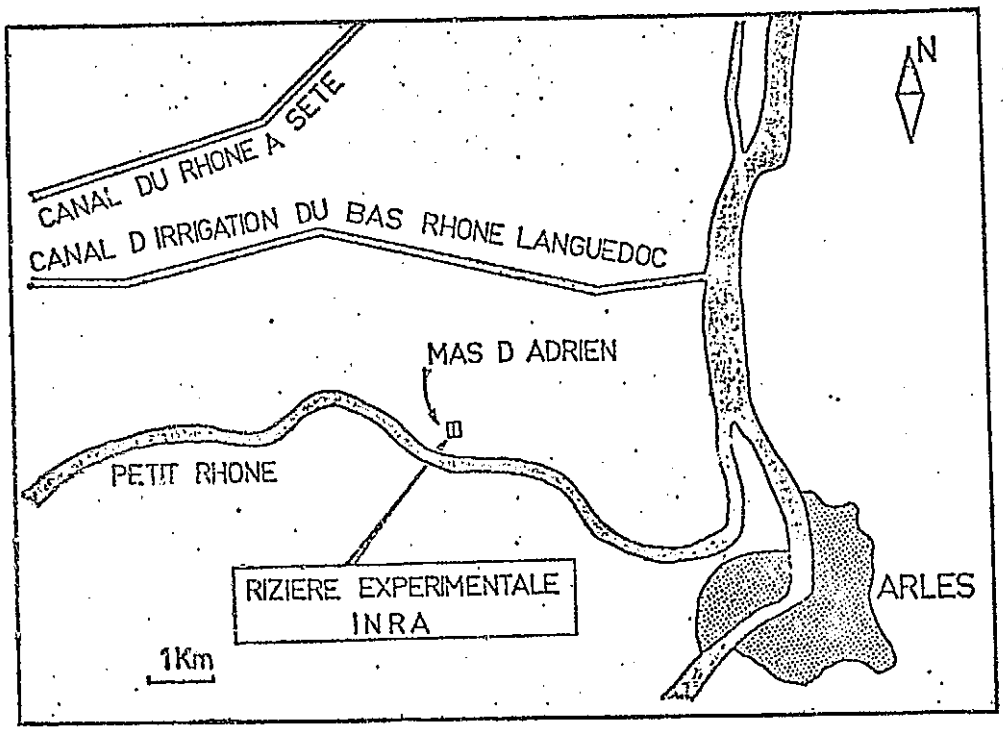

FIGURE 3

"MAS D'ADRIEN" EXPERIMENTAL PARCEL

n°	Date of passage	DEVELOPMENTAL STAGES			Soil conditions
		DELTA	EURIBE	BALILLA 28	
1	2 MARCH	-	-	-	DRY
2	20 MARCH	-	-	-	WET
3	7 APRIL	-	-	-	WET
4	25 APRIL	-	-	-	DRY
5	13 MAI	LE	LE	LE	UNDER WATER
6	31 MAI	LE	LE	LE	UNDER WATER
7	18 JUNE	DT	LE	LE	UNDER WATER
8	6 JULY	DM	DT	DT	UNDER WATER
9	24 JULY	GO	DM	DM	UNDER WATER
10	11 AUG.	MF	DE	GO	UNDER WATER
11	29 AUG.	LA	>MF	MF	UNDER WATER
12	16 SEPT.	PA	LA	LA	UNDER WATER
13	4 OCT.	FC	DU	PA	PARTLY AT ZERO LEVEL
14	22 OCT.		FC	DU	-
15	9 NOV.		HARVESTED		-

TABLE 1 : DEVELOPMENTAL STAGES OF RICE PLANT OBSERVED AT EXPERIMENTAL FIELD.

DATE OF PASSAGE	AIR TEMPERATURES			MIN ACTIONO-THERMAL INDEX		WIND		SOIL TEMPERATURES			SUN (h)	RELATIVE HUMIDITY		RAINFALL mm
								a-10 cm		a-50 cm				
	Mini	Maxi	moy	At 10 cm	At 50 cm	DIR	MOY (m/s)	Mini	Maxi			<40 %	>80 %	
75.03.02	11,5	13,5	12,5	3,2	5,0	-	-	9,5	10,0	9,6	-	0	11	0,0
75.03.20	0,4	8,5	4,5	6,1	3,0			7,3	8,9	8,8	-	0	16	49,8
75.04.07	5,0	15,5	10,3	0,0	1,0	8	2,6	8,0	9,5	9,0	5,6	0	11	0,2
75.04.25	9,2	29,0	19,1	5,2	7,1	8	6,8	14,5	15,1	15,1	12,3	20	0	0,02
75.05.13	10,7	21,7	16,2	8,1	9,8	8	3,6	11,4	15,5	14,1	12,0	0	6	0,0
75.05.31	13,1	17,0	15,1	8,9	11,4	1	2,8	15,8	19,4	18,4	1,8	0	18	11,1
75.06.18	9,9	21,9	15,9	4,2	7,7	8	5,7	15,4	20,0	20,4	13,0	0	0	0,0
75.07.06	16,8	25,0	20,9	14,2	15,8	8	1,6	16,9	20,2	20,9	11,5	0	13	0,0
75.07.24	17,2	30,7	24,0	15,8	16,9	9	1,8	20,7	26,4	24,2	9,2	0	2	0,0
75.08.11	18,0	28,5	23,3	15,6	16,4	8	0,8	21,4	26,5	26,0	12,8	0	11	0,0
75.08.29	16,4	25,2	20,8	14,0	16,0	9	1,4	16,4	22,7	21,4	2,2	0	15	0,1
75.09.16	13,5	24,8	19,2	12,0	13,0	5	1,4	14,0	19,5	20,5	0,8	0	14	0,0
75.10.04	13,5	27,7	20,6	11,9	12,9	8	3,1	13,0	20,7	19,7	9,5	0	9	0,0
75.10.22	6,5	18,0	12,3	3,0	5,0	9	0,8	8,0	13,6	13,5	0,7	0	18	0,2
75.11.09	5,6	9,4	7,5	2,8	3,7	9	2,6	6,0	10,2	12,5	0,0	0	24	18,3

TABLE 2 : CLIMATIC MEASUREMENTS RECORDED AT THE "MAS DE GOUINE" AREA

2. Minimum actinothermal index : recorded by thermometers at 10 and 50 cm below the soil.

3. Wind : prevailing direction (1 : NE, 2 : E, 3 : SE, etc ...). and average velocity at 2 meters above the ground, measured by anemometer (expressed in meters per second).

4. Soil temperature : measured at - 10 and - 50 cm beneath short grass.

5. Sun : expressed in hours and tens of an hour using Campbell heliograph recordings.

6. Relative humidity . Expressed in ;

a. Number of hours during which the relative humidity was less than 40 %,

b. Number of hours during which the relative humidity was over 80 %.

7. Rainfall : expressed in mm per day, obtained by a rain gauge.

In the meantime, experiment is carried out for-studying the growth stages of several rice-plant varieties : Balilla 28, Cigalon, Cristal, Delta, Euribé when the sowing dates are intentionally spread out in time.

The earliest date was April 21 and the latest, May 05.Table 3 gathers the evolution of each variety allowing to one of the 4 sowing dates. On can note that the difference of growth stages,important in the first phases, decreases more and more to harvest. Further investigations will be done to study the relation between climatic conditions and the growth stages with the data from Table 2 and Table 3.

II - PLANNING OF LANDSAT 2 DATA PROCESSING.

In conjunction with ground observations and measurements, a plan of the treatment of the LANDSAT data can be made for each passage of the satellite.

The first stage of such treatment involves rice field mapping,rice-varieties mapping and diseases detection (Table 4).

VARIETY	SOWING	First leaf	Beginning of Tillering	Beg. of Stem Elon-gation	Boots just visible	Heading to flowering	End of flowering	Early milk stage	Early dough stage	Caryopsis hard	Good for harvest	OBSERVATIONS
BALILLA 28		07.05	08.06	25.07	06.08	12.08	20.08	27.08	04.09	18.09	08.10	
CIGALON		07.05	08.06	12.07	23.07	31.07	08.08	13.08	21.08	08.09	22.09	Abnormaly long cycle
CRISTAL	21.04	07.05	08.06	25.07	06.08	10.08	20.08	25.08	06.09	21.09	03.10	
DELTA		07.05	08.06	20.07	26.07	03.08	09.08	20.08	02.09	15.09	27.09	Heterogeneous emergence
EURIBE		07.05	08.06	22.07	06.08	11.08	23.08	04.09	15.09	28.09	05.10	
BALILLA 28		12.05	04.06	20.07	31.07	09.08	14.08	27.08	03.09	22.09	05.10	
CIGALON		12.05	04.06	12.07	20.07	30.07	08.08	13.08	21.08	07.09	22.09	
CRISTAL	29.04	12.05	04.06	20.07	29.07	06.08	12.08	18.08	27.08	15.09	30.09	
DELTA		12.05	04.06	12.07	20.07	02.08	09.08	L8.08	25.08	09.09	22.09	
EURIBE		12.05	04.06	26.07	02.08	11.08	19.08	29.08	09.09	25.09	05.10	
BALILLA 28		15.05	06.06	28.07	03.08	09.08	18.08	25.08	09.09	25.09	14.10	
CIGALON		15.05	06.06	12.07	19.07	31.07	08.08	13.08	21.08	09.09	22.09	
CRISTAL	07.05	15.05	06.06	26.07	02.08	09.08	16.08	23.08	30.08	20.09	03.10	
DELTA		15.05	06.06	15.07	22.07	03.08	11.08	21.08	27.08	11.09	25.09	
EURIBE		15.05	06.06	30.07	06.08	12.08	21.08	28.08	09.09	22.09	07.10	
BALILLA 28		25.05	10.06	28.07	04.08	09.08	21.08	27.08	11.09	25.09	14.10	
CIGALON		25.05	10.06	12.07	19.07	31.07	09.08	18.08	25.08	12.09	25.09	
CRISTAL	15.05	25.05	10.06	30.07	04.08	08.08	16.08	24.08	03.09	16.09	06.10	
DELTA		25.05	10.06	17.07	25.07	05.08	12.08	21.08	28.08	10.09	25.09	
EURIBE		25.05	10.06	25.07	03.08	12.08	23.08	04.09	18.09	30.09	15.10	Disease

TABLE 3 : DEVELOPMENTAL STAGES OF 5 RICE PLANT VARIERIES AT STAGGERING SOWING DATES

DATES	OBJECTIVES	COMMENTS
MAY 13	Rice-field Mapping	Results including all natural bodies of water.
MAY 31	Rice-field Mapping	Difficulty : rain gauge reading 11 mm
JUNE 18	Rice-field Mapping	Difficulty : a certain number of rice fields were dried out for weed-killer treatment.
JULY 6	Rice-field Mapping	Results including rice-fields and marshes
JULY 24	Rice-field Mapping	Results including rice fields, marshed and temporarily flooded plots (vineyards, wheat-field after harvest ...)
AUGUST 11	Rice-field Mapping Disease detection	
SEPTEMBER 16	Rice-field Mapping Disease detection	
OCTOBER 4	Mapping of rice varieties	
OCTOBER 22	Mapping of rice varieties	

TABLE 4 : PLANNING OF LANDSAT 2 DATA PROCESSING

1. Mapping of surfaces under water : determined by the classification of imagery on the following dates : May 13, May 31, June 18, during which the rice fields were under water. This poses several problems :

- Natural bodies of water give the same response as rice fields,
- May 31 is distorted by the appearance of rain (rain gauge reading : 11 mm),
- One June 18, certain areas were dried out for various chemical weed-killer treatments.

2. Mapping out rice fields in the vegetation stage : the July 6, July 24, and August 11 passages can be used to identify the rice under following states : emergence to tillering, stem elongation , booting,appearance of first leaves above the water ; in addition, rice fields can be distinguished from other areas of vegetation in the MMS7 band, and from natural bodies of water in the MSS5 band.

Certain difficulties may arise :

The marshes, which are extensive, particularly in the southern part of the zone under study, can appear as rice fields (grass on marsh).

On dates at the end of July (July 24) certain fields were purposely flooded by users (vinegards, orchards).

3. Mapping out rice varieties :

The October 4 and 22 imagery can be used to discriminate between different varieties of rice.

On October 4, the Delta variety was at the end of the vegetation cycle and the plants were yellow ;the Euribé variety was starting to turn yellow; the Ballila 28 was still green.

On October 22, most of the rice fields of the Delta variety had been harvested; the plants of the Euribe variety were yellow; the Ballila 28 plants were just beginning to turn yellow.

4. Detection of diseases:

The passages on August 11 and 29, October 3 and 4, can be used to detect diseases which can be found at different points in 1975.

The disease is caused by PYRICULARIA ORYZA on parcels over treatment with nitrogen fertilizer; when occur particularly wet and harm climatic conditions within several days.

The visible signs of the disease are detected on the field from August 10 .

III - LIST OF LANDSAT 2 IMAGERY AVAILABLE OVER FRENCH TEST-SITE n° 4.

The LANDSAT 2 images received today are the following:

n°	DATE	IDENTIFICATION	OBSERVATION
1	JUNE 17	2146-09453	Cloud covering upon test-site - Unusable
2	JULY 4	2163-09394	Unusable
3	JULY 5	2164-09453	Unusable
4	JULY 6	2165-09511	Good - Compatible - Tape ordered
5	JULY 23	2182-09451	Good
6	JULY 24	2183-09505	Good - Compatible Tape ordered
7	AUGUST 11	2201-09502	Good - Compatible Tape ordered
8	AUGUST 29	2219-09500	Unusable
9	OCTOBER 3	2254-09440	Good - Compatible Tape ordered
10	OCTOBER 4	2255-09495	Good

On the whole, 6 imageries are available 2 of which are redondant (July 23 or 24, October 3 or 4).

Allowing for these available data, processing is planned for :

1. Mapping of rice fields (july 6 and july 23 scenes) by multispectral data classification
2. Mapping of rice-fields and disease detection (august 11 scene) by multispectral data classification
3. Mapping of rice-field by multitemporal data classification (july 6 and 23, august 11) to eliminate the errors caused by the complexity of particularities;presence of marshes, existence of intentional flooded fields other than rice fields, and the case of rice-fields dried out for chemical treatments.
4. Mapping of rice field into subclasses of different rice varieties by classification of data on october 3 scene.

IV - DATA PROCESSING.

The data processing developed by the Centre d'Etudes Spatiales des Rayonnements can be devided into 5 main parts :

- data management
- image display
- sampling
- classification

according to the chart in figure 4.

1. Data management.

The data come from either magnetic compatible tapes, or from digitalization of black and white transparencies on the Joyce-Loebl SCANDIG 25 microdensitometer.

In this case, each image is canned row by row with a step of 25 µ giving a numerical value from 0 to 255 par byte for each elementary surface 25 µ x 25 µ. Each LANDSAT imagery (MSS4 to 7) corresponds to 4 files of $2500 \times 2500 = 6,2 \times 10^6$ bytes.

Many problems result from the vast amount of data, and the solution may satisfy these conditions:

- reduction of the access to information time
- optimal data handling in a machine word (CDC 7600)
- perfect coincidence between the digitalized geographical zone in 4 MSS transparencies.

In this order image is devided into elementary zones of 60 x 60 points.

2. Display.

For the elementary restitution of the image, optical density histogram is studied by these methods :

- density slicing
- enhancement by equal probability quantisation and estimation of entropy
- extraction of normal elementary distribution.

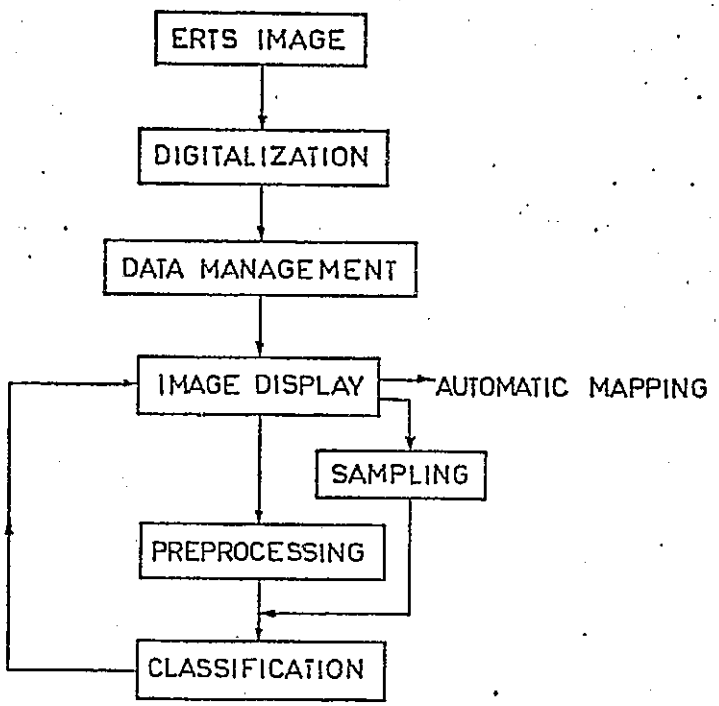

FIGURE 4 DATA PROCESSING

3. Sampling :

For supervised classification methods selected samples must be located according to ground truth determination and aerial photograph interpretation.

The process is refined to improve the homogeneity of the sample defined by their statistical characteristics.

4. Data reduction :

Necessary in the case of parameters redundancy, or when only certain parameters are specifically adapted to the type of classification.

5. Classification :

The classification model identifies a ground pattern resolution element represented by the feature measurement vector. Several models are used :

1. Minimum distance to the mean optical density measurement
2. Elliptical boundary criterion
3. Maximum likelihood ratio
4. Clustering method.

V - PRELIMINARY RESULTS FROM LANDSAT I IMAGERY.

The LANDSAT I images used for the preliminary investigations in the AGRESTE program concern 2 dates : March 21 and May 14, 1973. The purpose of the treatments applied is to test the proposed methods. The data do not correspond to the vegetation period of the rice and the aim of the data processing is to detected damp ploughed parcels in the month of March and flooded parcels in the month of May.

The first mapping was carried out using the May 14, 1973 imagery, when the rice fields were under water. (The flooding was announced in all of the parcels except for 1 or 2 in which the flooding took place May 15).

Samples are taken on areas located by observations on the ground determining rice parcels, vineyards, cereals, as well as some representative samples of the class "Rhone" and "cloud". The study of the responses to these samples in the MSS 5 and MSS 7 bands (figure 5) reveals the grouping of the following major classes :

water bodies
vineyards
cereals

In the class of water bodies two sub-classes can be distinguished : rice fields and the Rhone.

By studying these responses, it seems possible to reveal rice fields by means of density slicing method. The result (figure 6) shows that it is not possible to distinguish the responses of ricefields from those of the Rhone. Thus the result includes all water bodies in the zone. It can further be noted that the "petit Rhone" in this case has the same density as the vineyard samples.

The multispectral classification, from MSS 4 to 7, using supervised methods, is then applied to the zone. Figures 7 and 8 show the results of the mapping out of a zone 180 by 180 elementary points (an area of about 12.5 by 12.5 km).

Several things can be noted from the output listing :

- an East-West distortion due to the characters of the printer,
- each elementary spacing corresponds to a ground surface of 80 x 80 m
- similarity between graphic symbols chosen for the Rhone and rice fields,
- clouds are left blank.

On the result in figure 7, showing a part of the test-zone, the following can be noted :

- both the stream (petit Rhone), and the edges of the river (Rhone) are classed with the rice fields. The first conclusion to be drawn is that on that date, May 14, rice fields cannot be distinguished from natural water bodies.

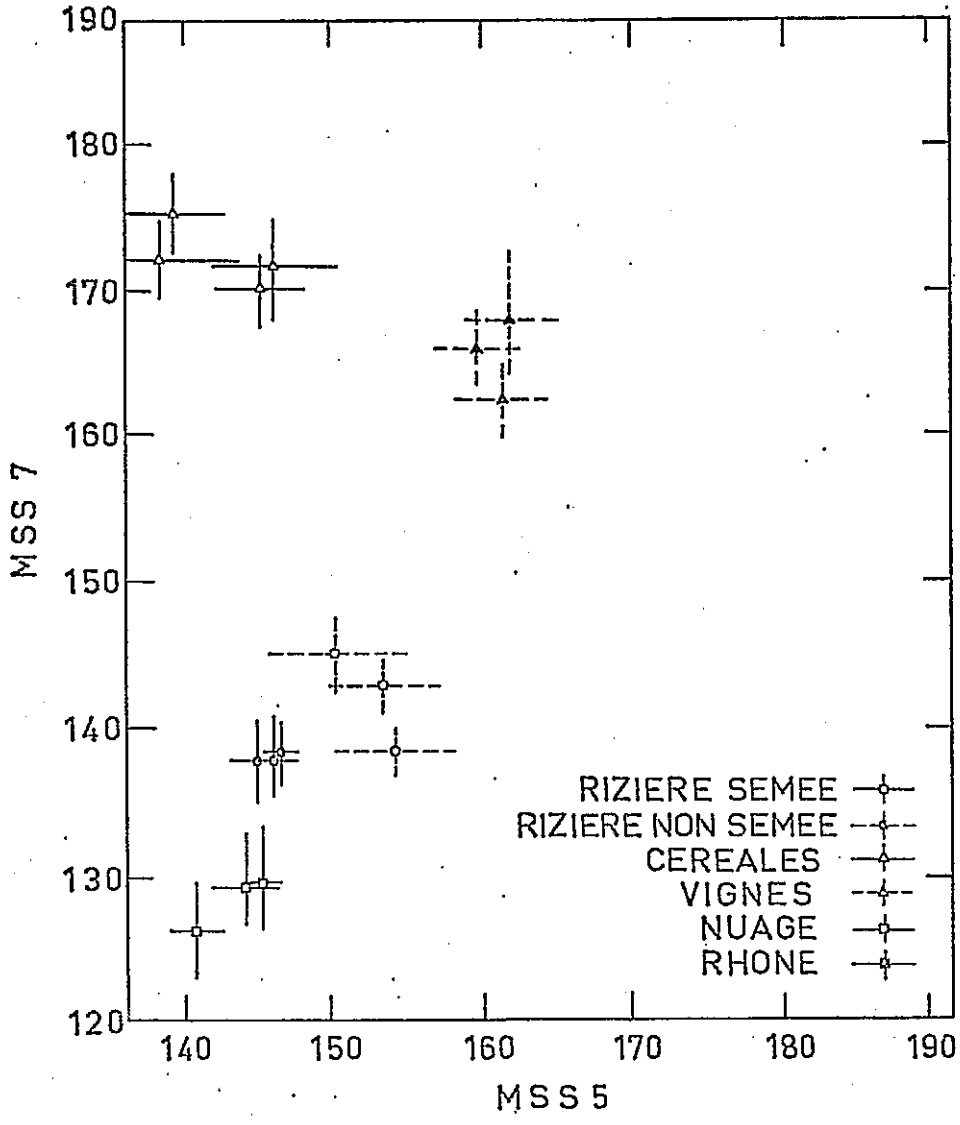

FIGURE 5

MSS 5 VERSUS MSS 7 SAMPLE RESPONSES FROM 14 MAY 1973 IMAGERY

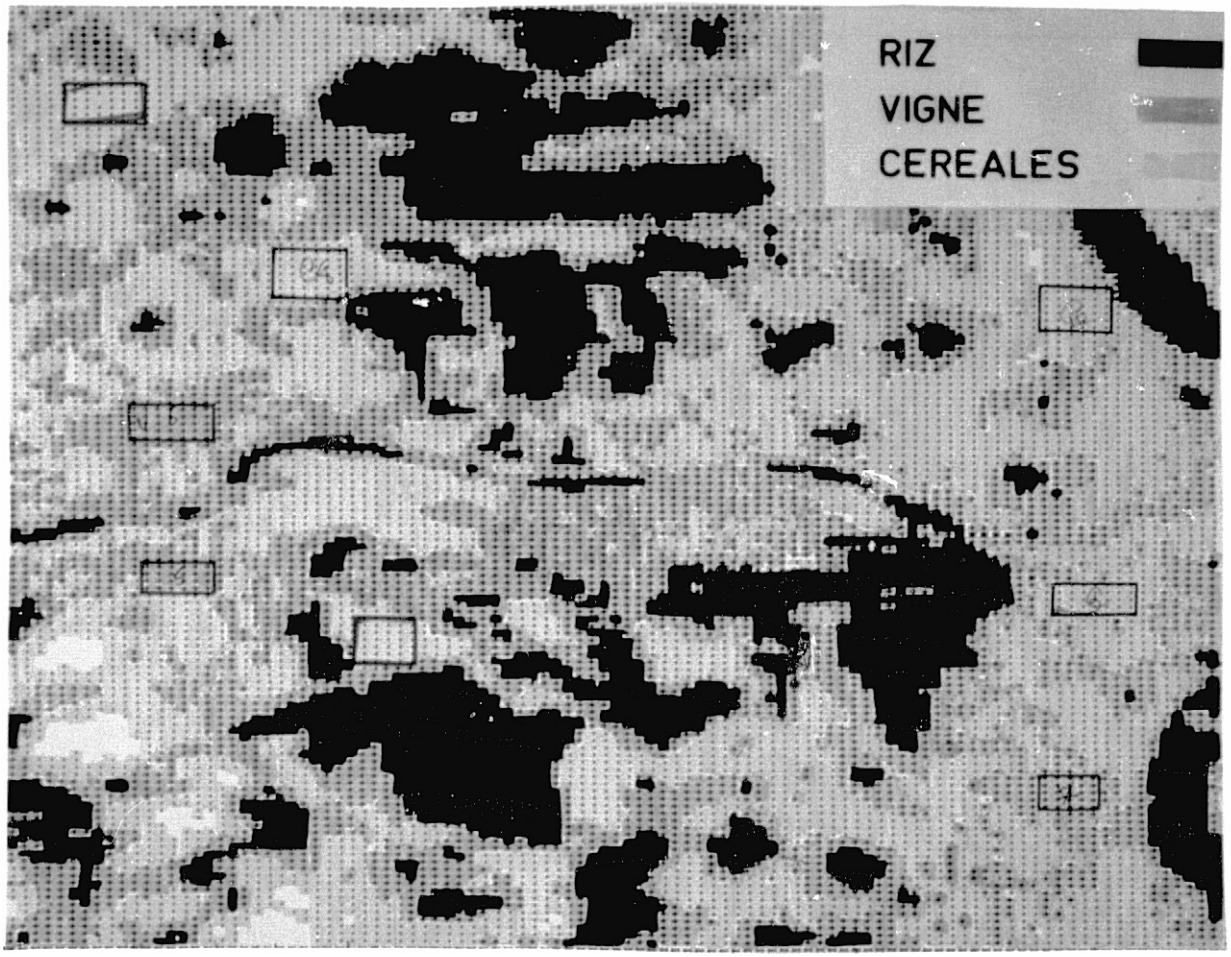

FIGURE 6

DISPLAY BY DENSITY SLICING

THE 14 MAY 1973 SCENE

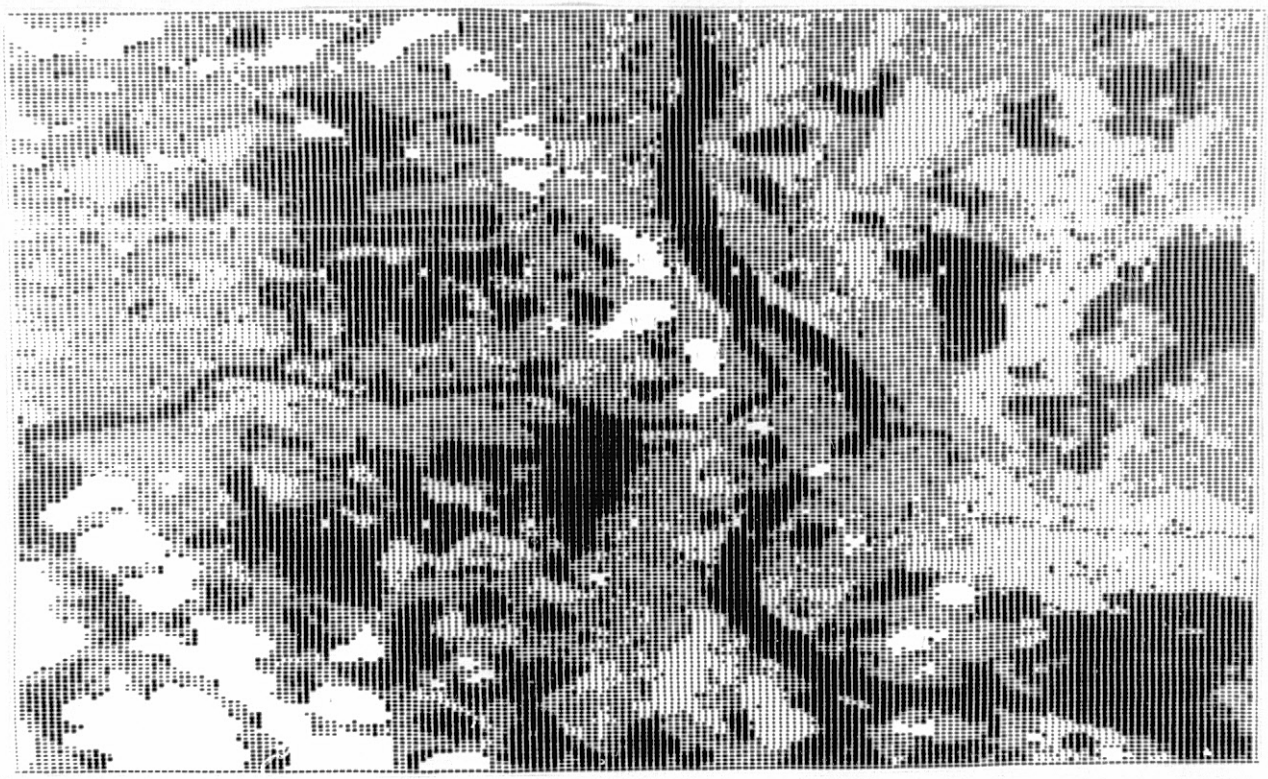

FIGURE 7

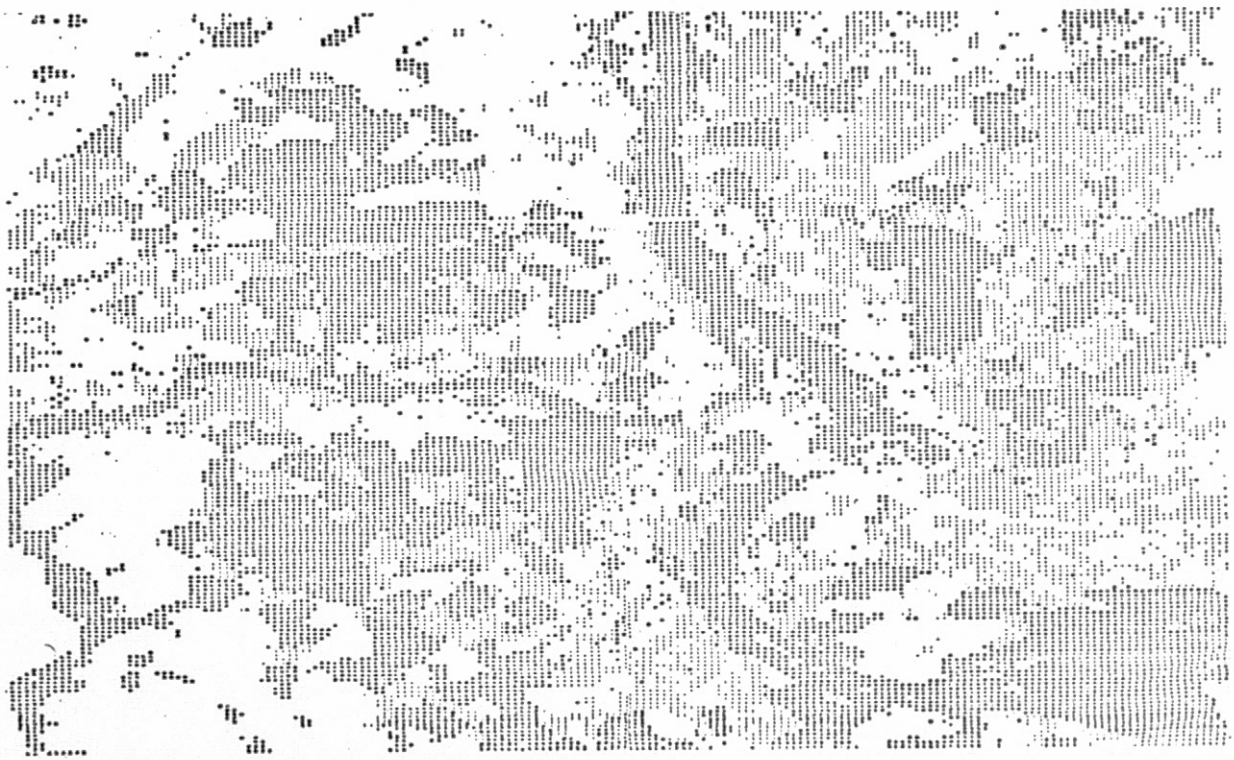

FIGURE 8

CLASSIFICATION OF THE 14 MAY 1973 SCENE

- urban areas (the town of Arles) have similar responses to those of vineyards,

- the test consisting of subdividing the class of rice fields is inconclusive.

In figure 8 the vineyard and urban classes have been removed from the results. The same symbol is given for rice fields, the Rhone and the Petit Rhone.

The second mapping is obtained using the MSS 7 imagery of March 21, 1973 and May 14, 1974. The purpose of this multitemporal classification is as follows :

- to test the coincidence between images taken on different dates,
- to eliminate confusion between rice field and water body responses,
- to class points below the clouds in one image or the other.

Figure 9 shows the study of samples taken at two different dates.

It can be noted that the classes studied, i.e., rice fields, the Rhone, the petit Rhone, urban areas, vineyards, cereals are separated on the figure.

The result of the classification in figure 10 shows that :

- it is difficult to distinguish between rice field responses and those of the petit Rhone and the outline of the Rhone, which proves that the samples studied in figure 5 do not cover all limiting cases, particularly for the outline of the river.

- the urban area is still mixed with the vineyard class.

The conclusion drawn from this result is that the periods of March and May are not adequate for discriminating between the above mentioned classes, although the goals fixed for this multitemporal mapping have been achieved.

Figure 11 shows the same result in which the three major classes appear : water bodies, vineyards, and cereals or grass. This output was made with the Calcomp tracer where water bodies are showed in blue, vineyards in green and other surfaces (cereals,grass ...) in red.

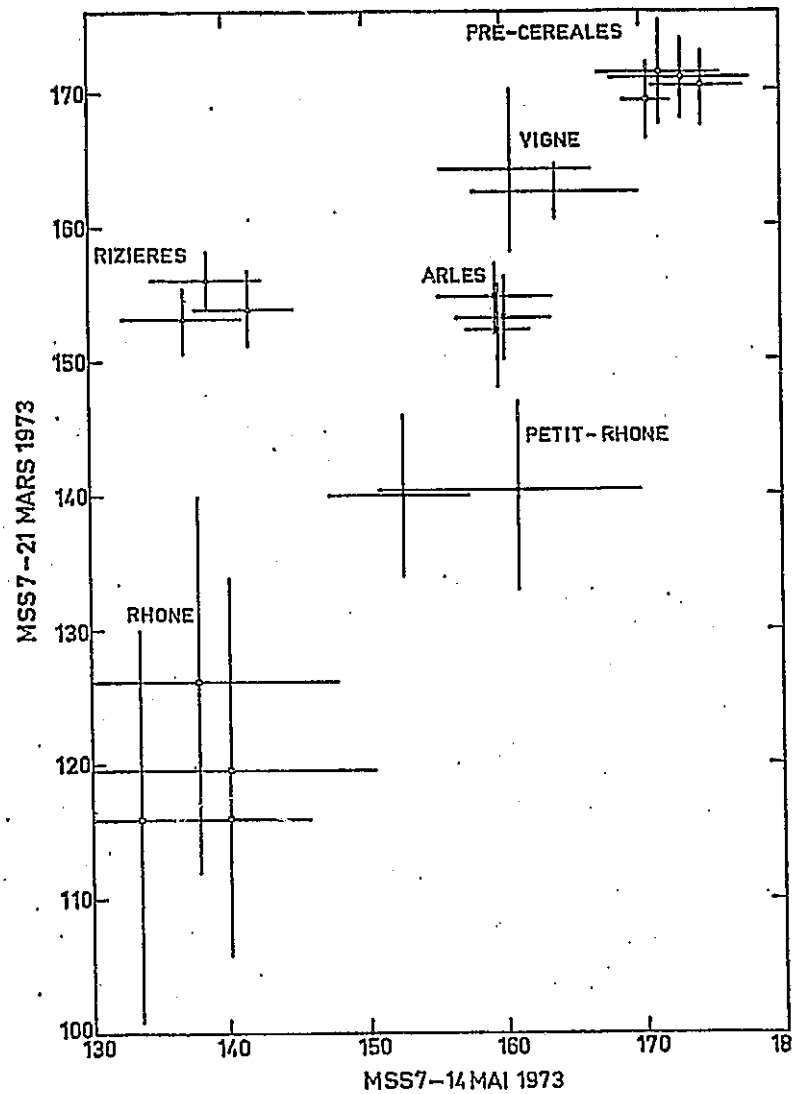

FIGURE 9

MSS7 SAMPLE RESPONSES, 21 MARS 1973 VERSUS 14 MAI 1973

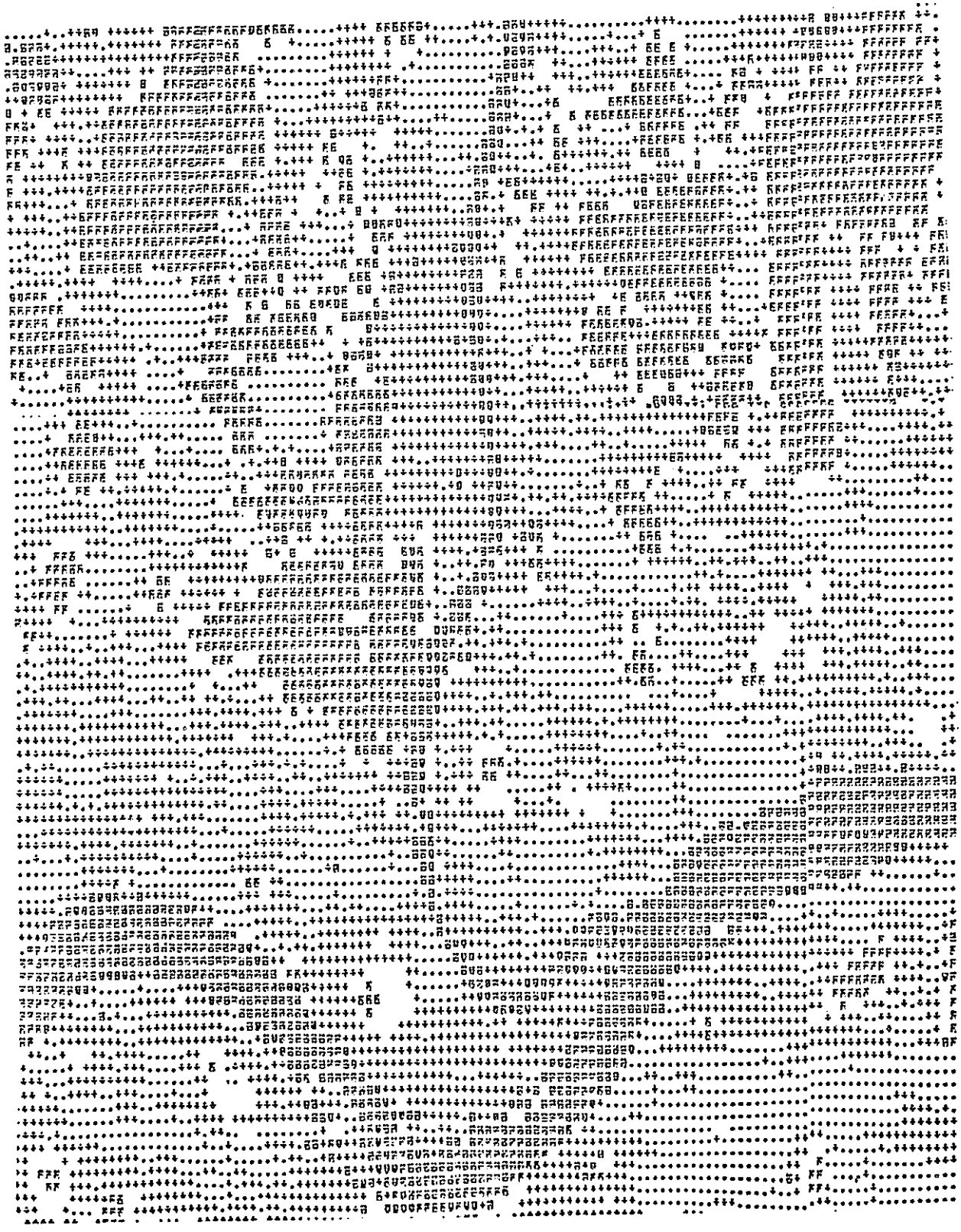

FIGURE 10

MULTITEMPORAL DATA CLASSIFICATION

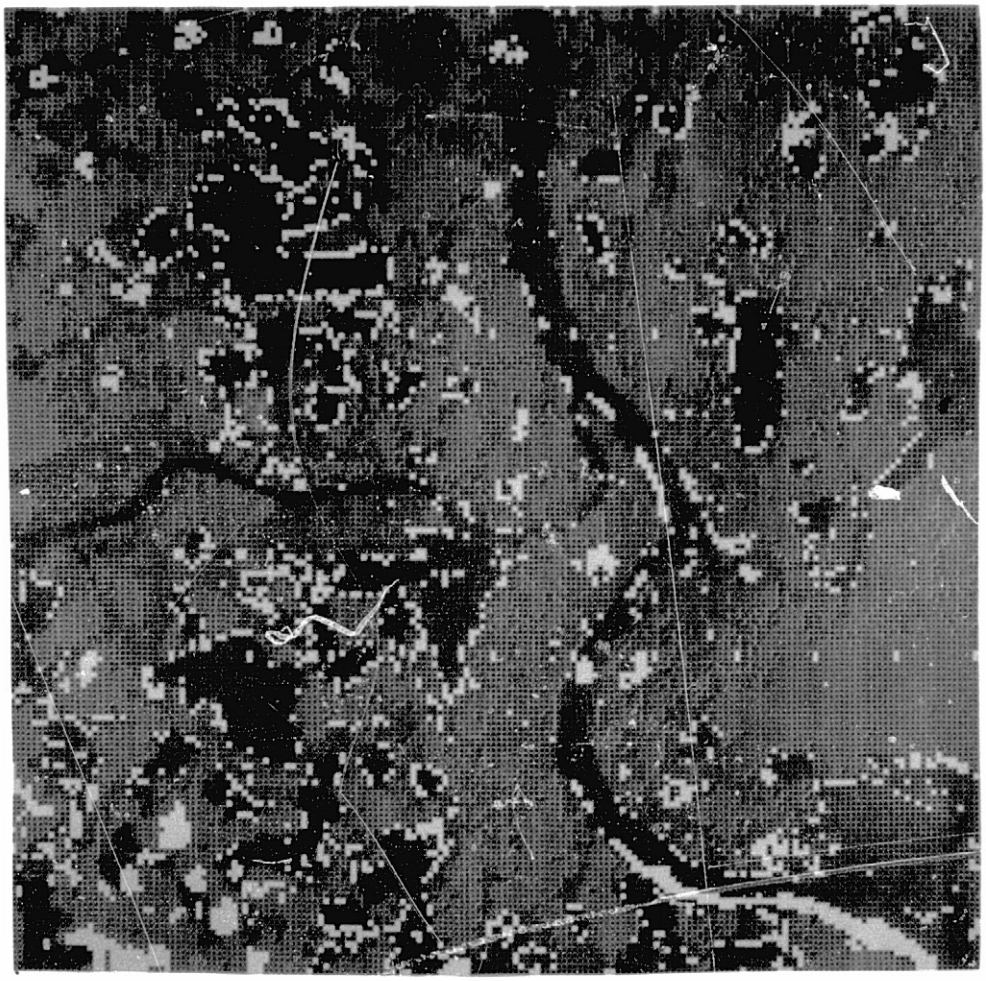

FIGURE 11

MULTITEMPORAL DATA CLASSIFICATION (CALCOMP TRACER DISPLAY)

VI - PRELIMINARY RESULTS OF THE AGRESTE PROGRAMME USING LANDSAT 2.

Studies have been made on the earliest imagery received, i.e., from July 23, 1975.

Figures 12, 13, 14, and 15 show the MSS 4 to 7 images of July 23, 1975 (2182 - 09451 scene).

In order to determine samples relating to rice fields on these images a study of the aerial documents is carried out, compiled by ground truth investigations.

1. Study of the aerial imagery :

The aerial images come from a project organized by the GDTA (Groupement pour le développement de la télédétection aerospatiale) of the CNES (Centre National d'Etudes Spatiales) on June 20, 1975.

The plane used for the project is the B17 of the IGN (Institut Geographique National) flying over the area at an altitude of 8,000 meters.

The data used within this study consists of images reconstructed using 10 - channel Daedalus Multispectral scanner recordings and specifically the two channels closet to the MSS 5 and MSS 7 bands of Landsat :

- channel 7 : spectral band from 650-700 nm ; image given in figure 16
- channel 10 : 9000-1100 nm, figure 17.

The imagery obtained has a resolution of about 20 m in the central part along the axis of flight, for a field of view of the MSS Deadalus of 2.5 mrd and for a flight altitude of 8,000 m.

In order to determine the stages of development of the rice at June 20, 1975 we refer to the observations made on June 18, 1975 (Table 2).

On this date, all the parcels are under water and different varieties of rice exhibit different stages of development : Delta is at the beginning of the tillering, the other varieties, Euribé and Balilla 28 are at the stage of the emergence (first leaf visible).

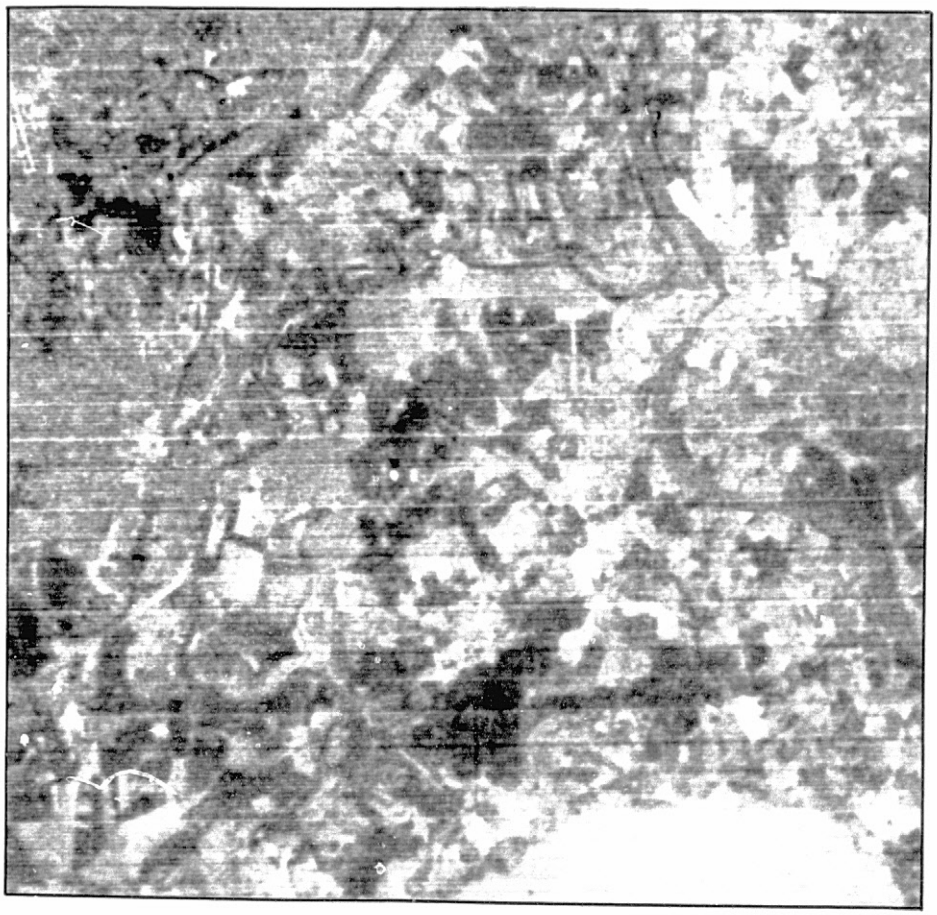

FIGURE 12

MSS4 LANDSAT 2 FROM 23 JULY 1975 SCENE - SCALE ≈ 1/200.000

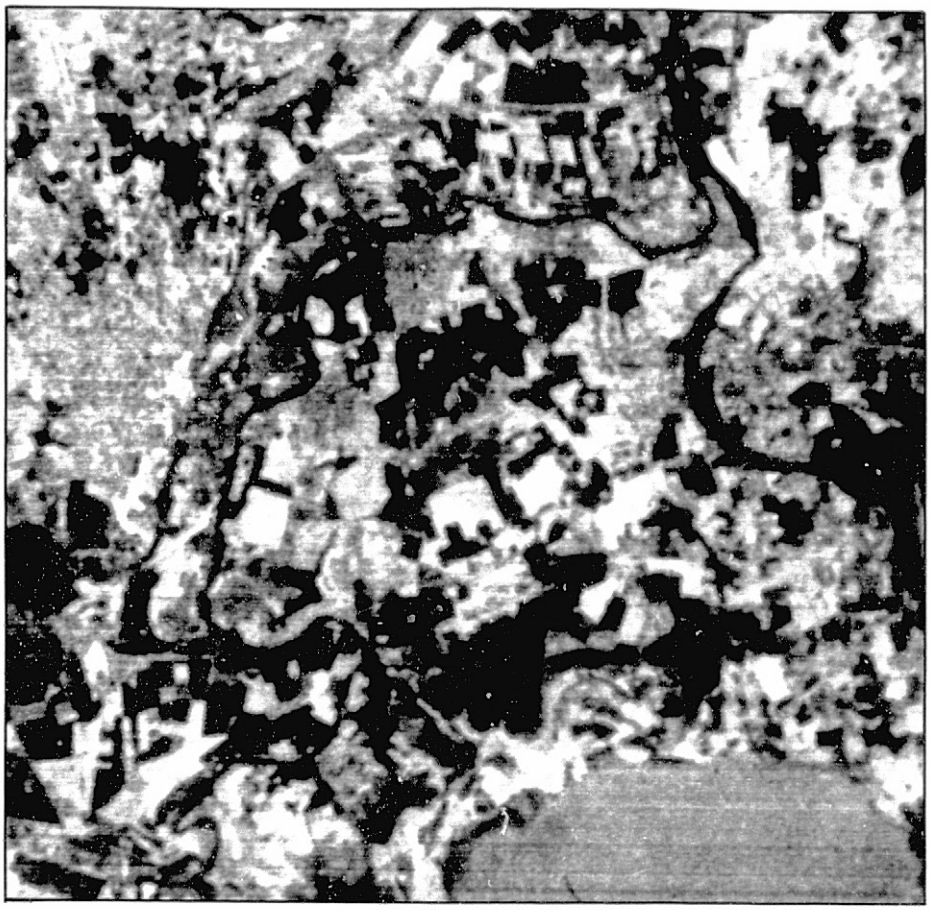

FIGURE 13

MSS5 LANDSAT 2 FROM 23 JULY 1975 SCENE - SCALE ≈ 1/200.000

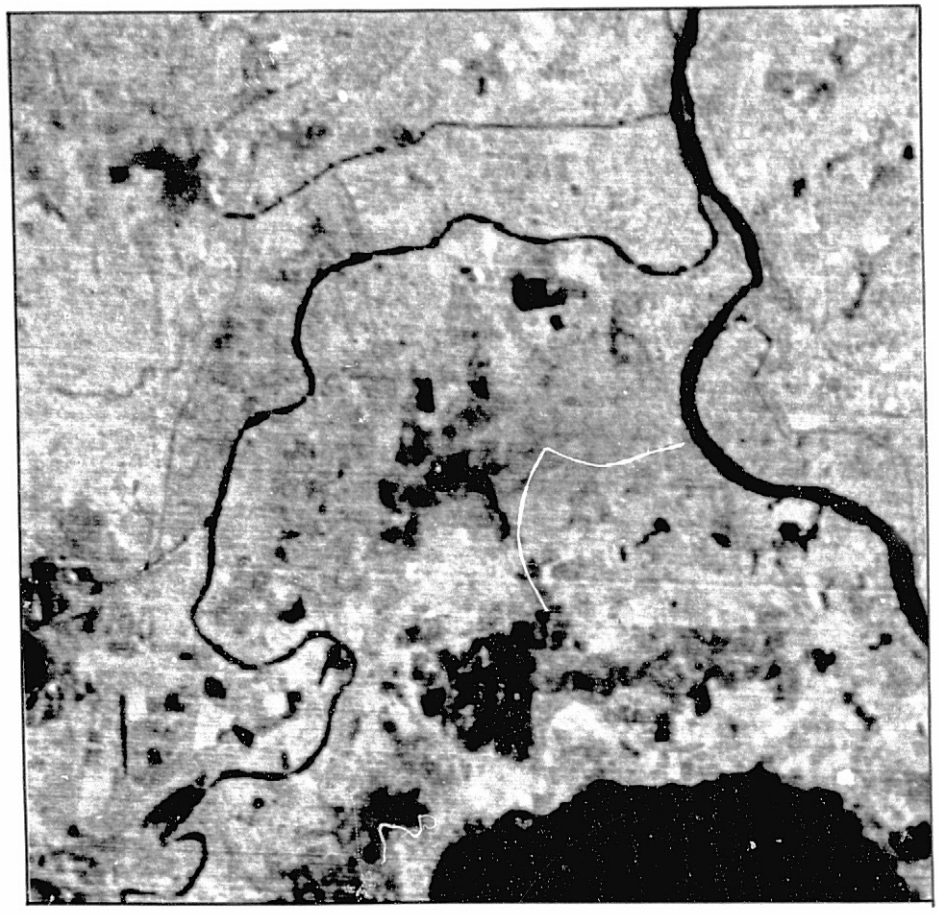

FIGURE 14

MSS6 LANDSAT 2 FROM 23 JULY 1975 SCENE - SCALE ≈ 1/200.000

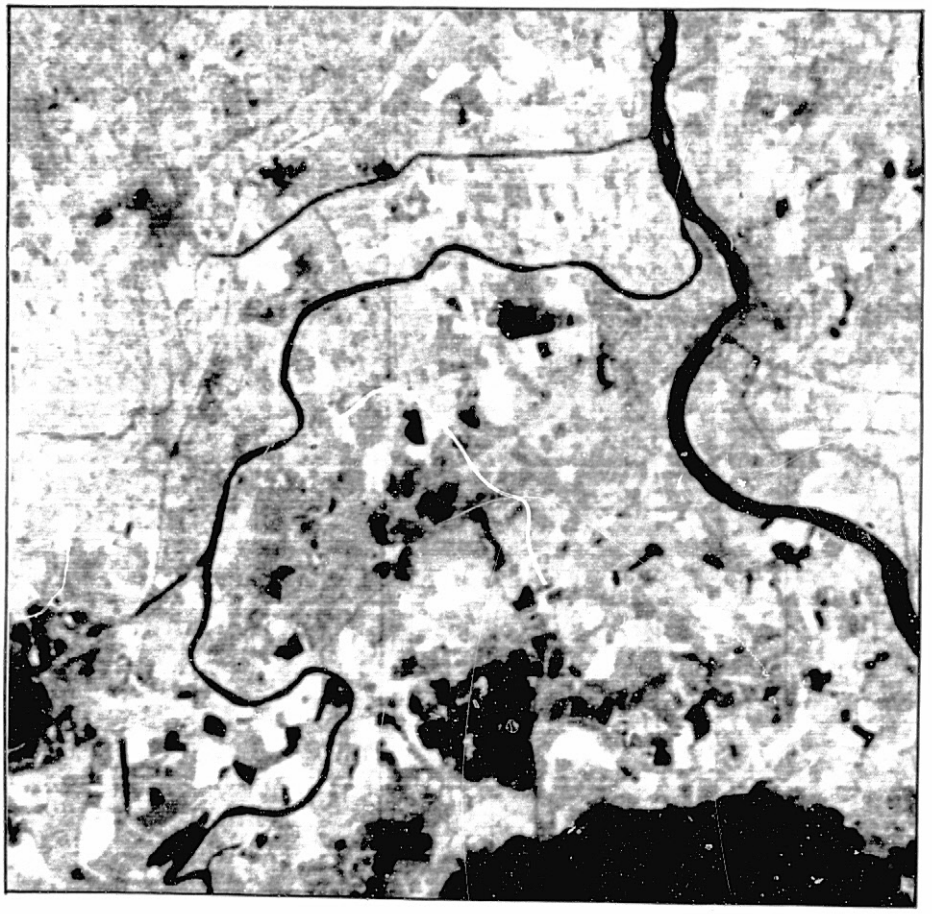

FIGURE 15

MSS7 LANDSAT 2 FROM 23 JULY 1975 SCENE - SCALE ≈ 1/200.000

FIGURE 16

DEADALUS IMAGE FROM 650-700 nm BAND - 20 JUNE 1975

FIGURE 17

DEADALUS IMAGE FROM 1000-1100 nm BAND - 20 JUNE 1975

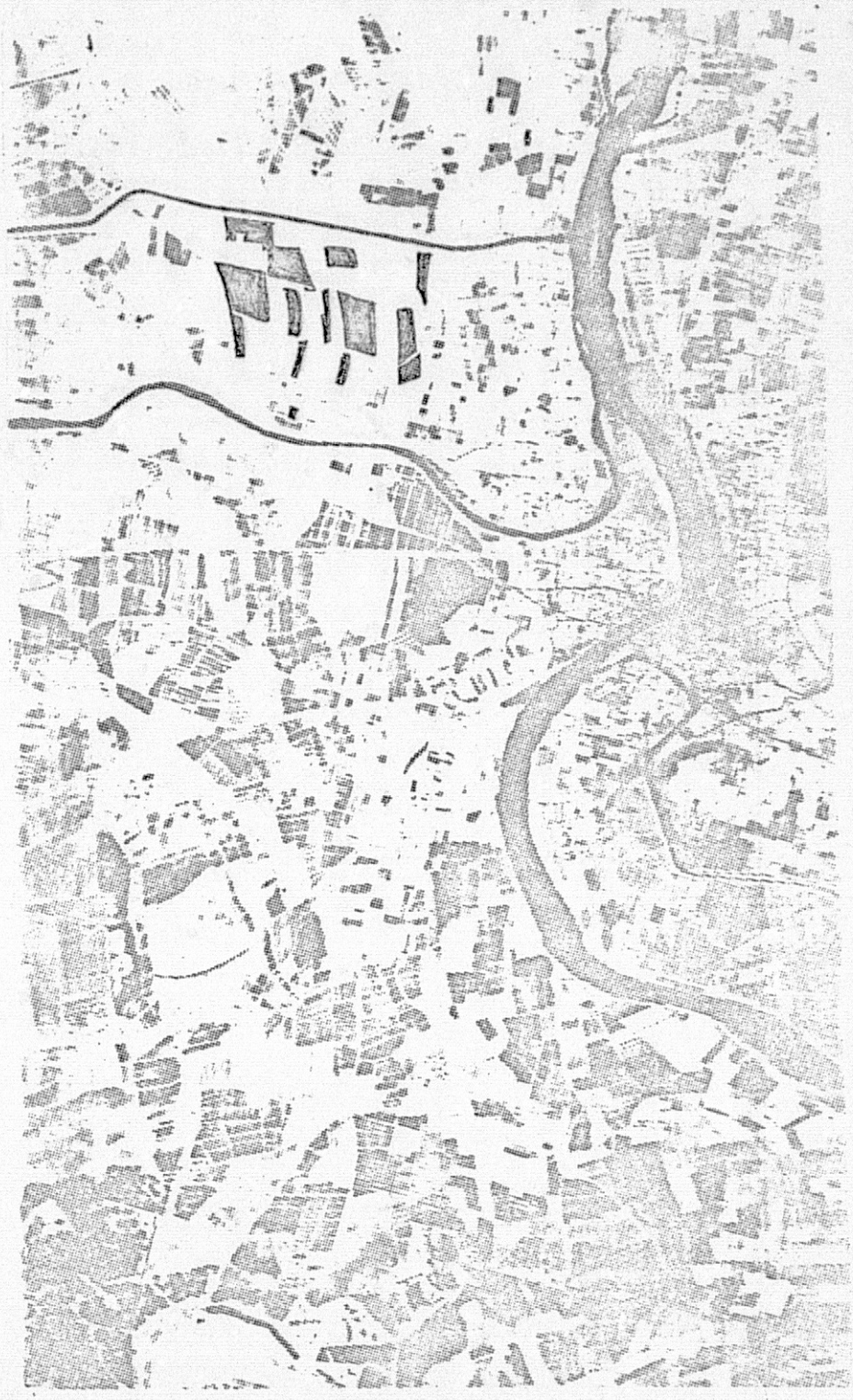

FIGURE 17 bis

In figure 17, which shows the image taken in channel 10 (near IR), we note the following :

- the optical density of the parcels depends essentially on their humidity. Thus the surfaces covered with water are dark on the document. The rice fields with Euribé and Balilla 28 are less dark than the Delta rice field, where the presence of more leaves reduce the reflectance of the surface.

- within a great area occupied by rice fields, there is a network of canals and dikes. On the satellite images, these areas which do not contain rice will be registered as rice fields. This fact will be taken into account for estimating the total area of rice planted, using cartography data.

In addition, on the date of the passage of the plane, several parcels of rice fields were temporarily dried out for purposed treatment.

In figure 16, which corresponds to the image taken in the 650-700 nm band (≃ MSS 5 of LANDSAT), we note the following :

- the areas covered with vegetation are dark on the document ; bare land is light. Thus, corn, cereal, soja, and grass fields appear dark, and trees along the river are black.

- the rice fields appear in intermediate grey tones, and the differences in density are observed in the parcels of rice located in figure 17 bis. Investigations can be made on specific areas in order to establish correlations between such differences in density and differences in variety or differences in sowing dates.

Studies are in progress for automatically classifying the Deadalus data in order to perform a precise mapping in a small area of the test zone for two purposes :

- to acquire ground truth for zones outside of the prospection area,

- to compare the results obtained by both types of data collection, i.e., satellite, and airplane.

2. Sampling:

The investigations to determine ground truth are in progress. At first, such a study is limited to the parcels of rice cultivation only.

By means of the aerial imagery and ground-based investigation, several rice fields are located on a map made by the IGN (figure 18). These samples are then studied on the Landsat imagery for supervised classification.

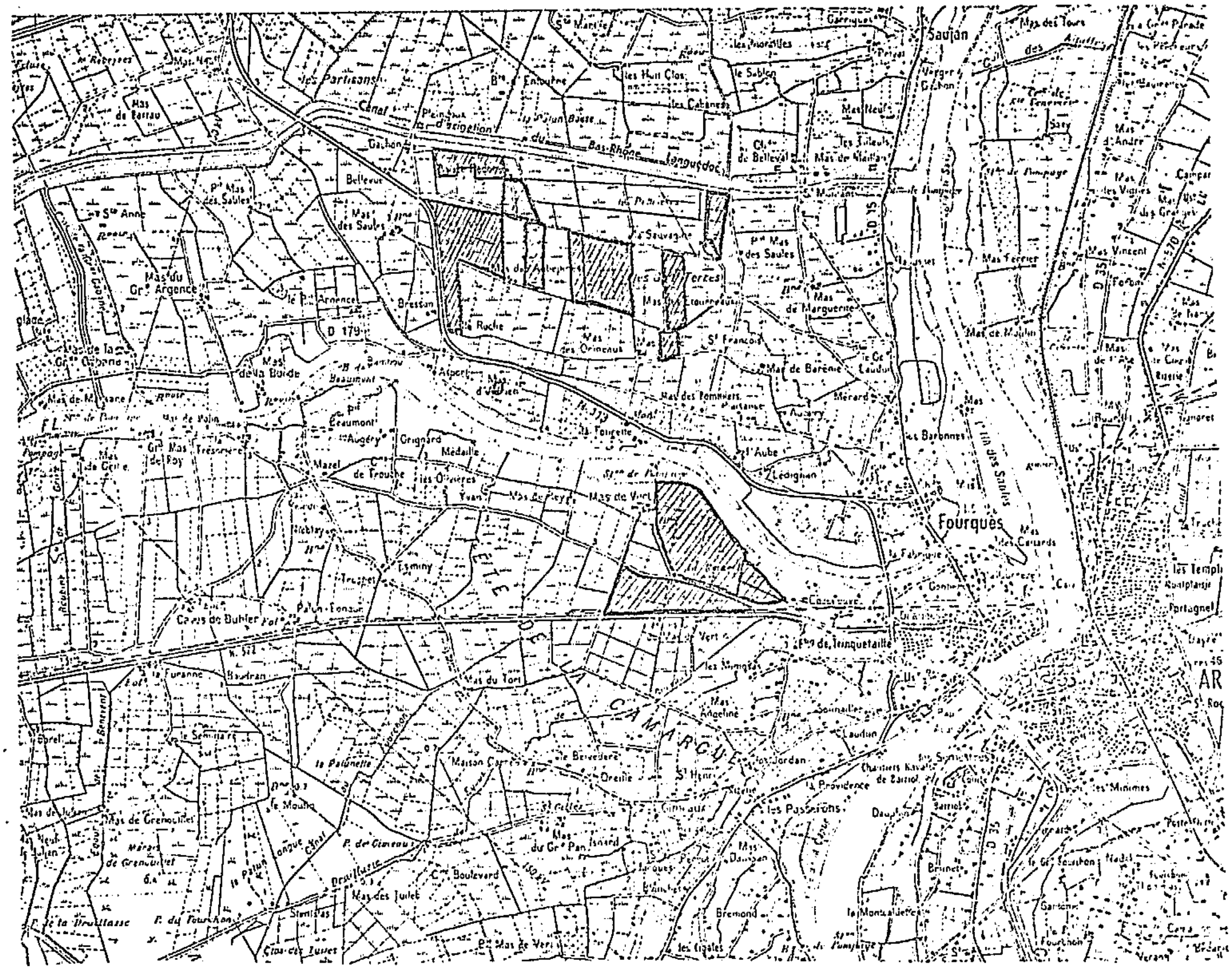

FIGURE 18

GROUND TRUTH LOCATED-FROM GEOGRAPHICAL MAP

3. Treatment of the Landsat 2 data.

The samples are located on the displays obtained by the density slicing of the histogram. Figures 19 and 20 show the displays of one part of the area using the MSS 5 and MSS 7 images.

We notice that in figure 20 the black spots marked 1 on the display correspond to an area covered with water. By ground-based investigation, it appears that this was a harvested wheatfield which had been flooded after burning in order to facilitate ploughing.

A field identified as a rice field (les Pébrières , marked 2 in figure 20) has a different response in different bands from the other rice fields taken for verification.

These anomalies prove that in order to be identify all rice cultivation areas in the Camargue, given the complexity of agricultural practices in this area, several dates are required for multitemporal classification, as well as a thorough knowledge of the ground truth.

The samples of rice cultivation taken are used to perform an analytical classification, the purpose of which is to classify rice cultivation only.

On the first rice classification results, showed in figure 21, we note that rice fields identified by ground truth investigations on figure 18 are well classified. But the results include also other non rice areas which behave like rice field at that date (stuff on water).

Data processing is in progress concerning multitemporal classification as well as disease detection.

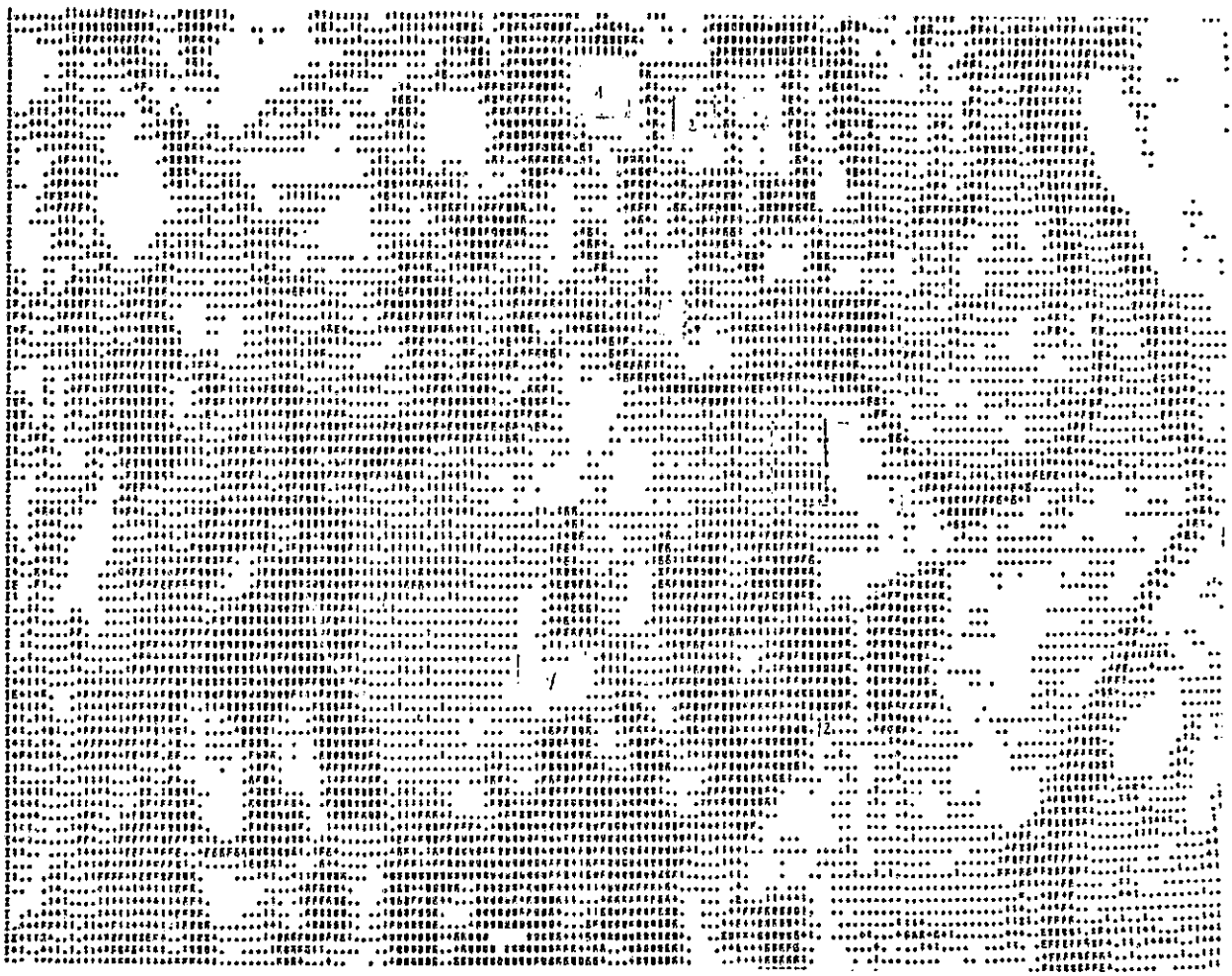

FIGURE 19

MSS5 LANDSAT 2 DISPLAY FROM 23 JULY 1975 SCENE

FIGURE 20

MSS7 LANDSAT 2 DISPLAY FROM 23 JULY 1975 SCENE

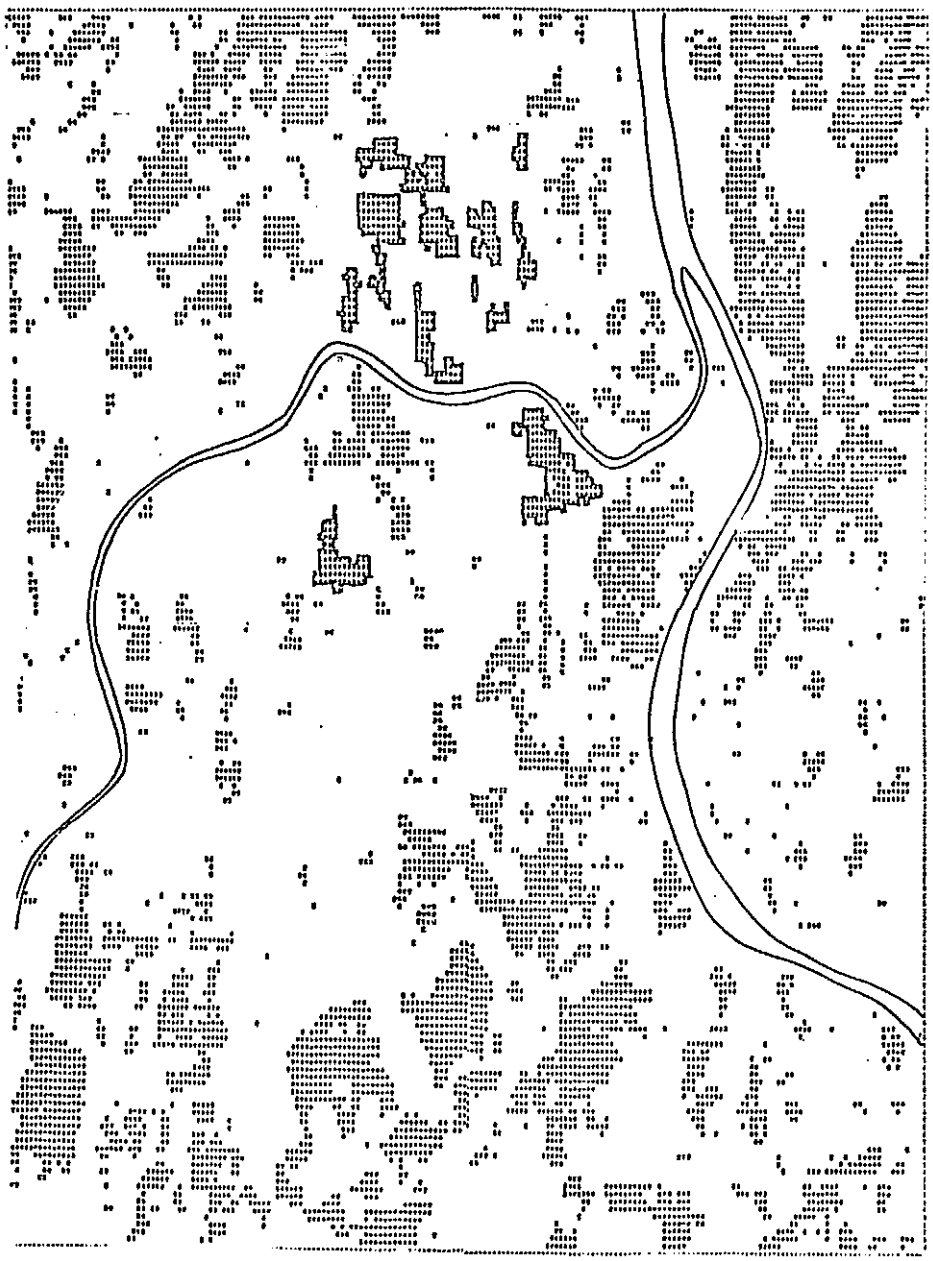

FIGURE 21

CLASSIFICATION OF THE RICEFIELD FROM 23 JULY 75 LANDSAT 2 IMAGERY

CHAPTER 2

FACIES DISTRIBUTION WITHIN ALLUVIAL DEPOSITS
INFRARED REMOTE SENSING RESULTS

B. DONVILLE

Abstract :

In fluviatile deposits, the distribution of granulometrecally different sediments (clays, sands, gravels) resulting from the flooding of former meanders and their development, is very difficult to study. The usual methods used are geophysical prospecting or core drills.

The use of false-color aerial photography is shown to achieve similar results much faster using a new method for observing these documents (by using a system of colored lights making it possible to alter each spectral response).

This paper describes study using this method in the lower plain of the Garonne, near St Jory (Haute Garonne), where our results were checked againt local hydrogeological and geophysical data.

It has thus been possible to reveal a zone of better permeability grouping several sandy cordons burried beneath superficial limons.

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INTRODUCTION

The localization of different facies within alluvial deposits has a highly practical importance both for hydrogeological problems (water flow, drainage) and for primary material problems (gravels ...) This distribution is the result of the location of former meanders and their development. Thus, the first part of this paper will be a brief review of the flooding patterns of present streams.

Generally, corresponding prospection studies are the result of specific information obtained either from core drills or from shallow geophysical prospecting (1). Obviously, in order to obtain sufficiently coherent data on these highly heterogeneous alluvial formations over a large area fine mesh campaigns must be available. Such work is therefore long and costly. Near infrared photographs (false color or IRC) can be used very profitably for this purpose when the spectral responses are analysed by an adequate apparatus. The second part of this article will describle the corresponding experimental apparatus after a review of the colorimetric composition of the IRC documents.

In order to evaluate the method, we compare our results with traditional processes, taking the lower plain of the Garonne near St Jory (Haute-Garonne) as an example. This will appear in the third part of the article.

Review of alluvial sedimentation

The formation of alluvial plains depends on the development of the balance profile of the body of water and of the extent of its flooding. For a certain state of these two components, the outline of the bed will become meander-shaped (2). The sedimentary deposits will have varying forms (see figure 1A) depending on the speed of the flow of water in the curve of this curvilinear channel. The concave bank will be strongly affected and will thus develop a steep bank. The converse occurs as the distance from the axis of the channel increases, fines and finer sediments are deposited on the convex bank .

The meander may extend along its concave side depending on the development of its equilibrium profile (figure 1-B). Thus successive deposits would be found in the same order of granulometric classification. Generally this movement is uneven so that between each deposit of the convex bank there appear shallow depressions giving a crescent shapped structure to the whole. When the converse occurs such as when the river tends to resume a more rectilinear pattern, the former chenal will be filled with increasingly finer sediments, and even more so as the former body will be abandoned more rapidly. At the final stage the abandoned body (dead arm) will form a depression.

All such depressions will provide preferred locations for silty sedimentation during seasonal flooding. This process as a whole thus provides a succession of coarse deposits (sands), in crescent form, alternating with finer (clay) areas (figure 1-C).

If this succession is observed longitudinally, one can then notice that there will be an average distribution of coarse formations which is less windy than the successive patterns of the stream channel. (figure 1-D). These deposits thus formed are practically always, and this is so for the alluvial plains of the streams of our region, entirely covered by flood basin deposits (clays). The former morphology is thus supposed to be covered up. However, due to the differential compaction between clays and sands, the slight altimetric variations reveal this former pattern on the surface (figure 1-E). This pattern can be complicated by the superimposing over a period of time, of similar cycles involving a superimposing in any order of the structures previously described.

All such granulometric variations within the alluvial deposits obviously cause changes in permeability. Hydrogeological research an such deposits will therefore consist of delineating the areas having a high concentration of sandy meanders (point bar). These do not necessarily correspond to areas of hydraulic drainage related to the form of the substratum.

Treatment of Infrared Color Photographs (I.R.C.):

Aerial photographs in the near infrared region (0.7-1 μ) of the surface of the Earth, can be obtained either in black and white or in color. The method for analysing which we describe later will show our reasons for preferring the latter form.

These infrared color photographs are called "false color" because the document is obtained by means of a spectral shift in the signals emitted by the ground. In particular, infrared information will be shifted to red and the red information to green (3).

In figure 2 we have given the effects of this spectral shift for two sets of information, (red and I.R.) and (green and I.R.). It can be noted, for example, than on the photograph a whole series of red varying with the vegetal density (real green) and with humidity (water absorbs I.R.) will be obtained. Thus for a given development of vegetation, we have a means of relating photographic information to soil humidity. In addition, it is well known (4) that the reflectance of the soil, in this wavelength band, increases as the size of its elements decreases and vice versa. Thus sandy soil will appear darker than clayey soil for the same degree of humidity.

If we now illuminate the photograph with a red light and transcribe the result into black and white, we note that we will have a darker grey if, for example, the I.R. information is low. One can argue analogously for green lighting (figure 2, on the right). Thus we have just seen how to transcribe certain information obtained very locally on IRC photographs into black and white. Now, the layout of cultivated parcels on alluvial deposits provides multicolored mosaics on a photograph, making small scale observations very difficult. In order to equalize the average of this information on the surface, it is necessary to be able to amplify or subdue either the red or the green information so that dark zones, for example, can be traced from one parcel to another. This is obtained in the montage in figure 3. The IRC photograph is illuminated by means of two flood lamps, one red and one green, each powered by a variable transformer so that the brightness can be adjusted individually. The document thus illuminated is televised by means of a camera on a tripod and displayed on a monitor screen. This makes it possible to analyse black and white images on which one can vary the definition (via the camera's focus), the brightness and the contrast (the TV screen).

Using this device we have treated the 74-2-IRC-257 photograph furnished by IGN (altitude : 5600 meters, time : 13:10, focal length 152/7) on the lower plain of the Garonne west of St Jory. Slightly enlarged, the document, illuminated in red only reveals a dark area lying parallel to the Garonne. The boundaries of this area are easier to distinguish when slightly out of focus.

With further enlargement, and with only low green lighting in order to avoid over darkening the photograph winding long line patterns are revealed. Actually, such observations are better revealed by a varying green brightness than by using a fixed value of the variable transformer.

Finally, by means of our method of green and red "balanced" lighting we can observe a series of concentric, primiarily curvilinear darkening zones . These results are sketched in figure 4.

Comparison with ground truth :

In order to establish the meaning of these observations, we have grouped together the previously collected subsoil data from the zone under study. In this way a study of electrical soundings (GRGM-SGR Midi-Pyrénées-Mining Code n° 956-7-252) has in particular provided the resistivity and form of the basal surface of the surface limons. In addition, by grouping the observations made on the wells of this zone by the BRGM-SGR Midi-Pyrénées we have reconstructed the pattern of the piezometric surface of the phreatic flow using observations made during 3 different periods (July, 1964; April, 1966; and May, 1966) (5,6).

In figure 5 we have shown certain information relating to the observations taken from IRC photography.

Thus, if we compare the distribution of resistivities of the surface terrain with information obtained by balanced lighting, we generally note a good agreement between light zones and high resistivities. In figure 4, for example, we have sketched the development of the resistivity along two alignments and the position of the dark zones meeting them. This thus leads us to interpret these local dark areas as being rich in clays and highly humidified. Their curvilinear concentric arrangement therefore outlines well the layout of former sandy meander cordons.

Furthermore, the alignments of the areas of high surface resistivity and, simultaneously, relatively low limon thickness correspond well to those revealed under green light. We can interpret these wavy lines as former major beds of bodies of water at a stage of development prior to that leading to the sedimentation of the above mentioned cordons. In fact east of Beldour these cordons of average NNW-SSE alignment line up in some way with these long line patterns.

Finally the extensive dark area obtained using red lighting is similar to the isopiezometric map. In fact, it seems to correspond to the area of low hydraulic gradient and thus of high permeability on the map. This is event more logical since it is noticeably lined up along the high points of the basal surface of the limons. Thus, in this zone, the vegetation, when there is any, would present a low rate of evapotranspiration compared with the very aerated state of the subsurface, while the bare topsoil shows the more sandy influence of the subsoil on its granulometry.

These results thus make it possible for us to locate the theoretical outline that we reviewed for the formation of alluvial sediments :

- An early stage with filling by more or less coarse materials corresponding, for example, to line A or B (figure 4) brought out by means of green lighting (it seems in effect that the filling of B may be more clayey because situated within the extensive dark zone).

- A second stage of sedimentation with the formation of very many point bars. The development of the channel as spared the first cordons formed and has rather "leaned" on them as is often evidenced by the parallelism between lines. The association of all these crescents creating a longline pile strongly. highly permeable characterized as a whole in red light.

Conclusion :

The localization of the position of former main beds within the alluvial deposits can be carried out using "false color" infra-red photographic documents. This treatment is improved by the use of a colored lighting system (red-green) with variable brightners coupled to a black and white TV circuit.

This preliminary study shows that it is possible to find not only the main axes of permeable formations but also the particular form of each sandy point bar.

This flexible rapid method therefore provides and inexpensive means of preparing a mechanical or geophysical prospecting study in an alluvial medium.

N.B. We would like to thank Messieurs Angelier , Gourinard , Rey and Vincent of the Centre d'Etude et Amenagement des Ressources Naturelles (University Paul Sabatier) and Messieurs Arles and Flouzat of the Service de la Carte de la Végétation (Centre National de Recherche Scientifique) for the advice and material aid which they were willing to offer us.

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Figure Captions :

Figure 1 Diagram of the distribution of fluviatile deposits (The letters A, B, C, D, and E are referred to in the text).

Figure 2 Effect of spectral shift on the appearance of the IRC photographs with or without colored lighting.

Figure 3 Observation system for balanced lighting. C-Television camera - variable transformer.

Figure 4 Main observations obtained by means of the system in figure 3 on photograph 74-IRC-2-5. Heavy broken line : alignments revealed under green light (A, B : see text). Shaded area : Extensive dark area under red light. Dotted area : local dark areas under balanced lighting. The double line at top left and left marks the edge of the IRC photograph

Figure 5 Main geophysical and hydrogeological information. Relative pattern of the piezometric surface of the phreatic layer. X and Y : electrical sounding alignments showing in figures the amount of primary terrain resistivity. The black dots correspond to the dark areas obtained in figure 4. Heavy broken line : average alignments of shallow ground having higher resistivity.

AVERAGE DISTRIBUTION OF COARSE FORMATIONS

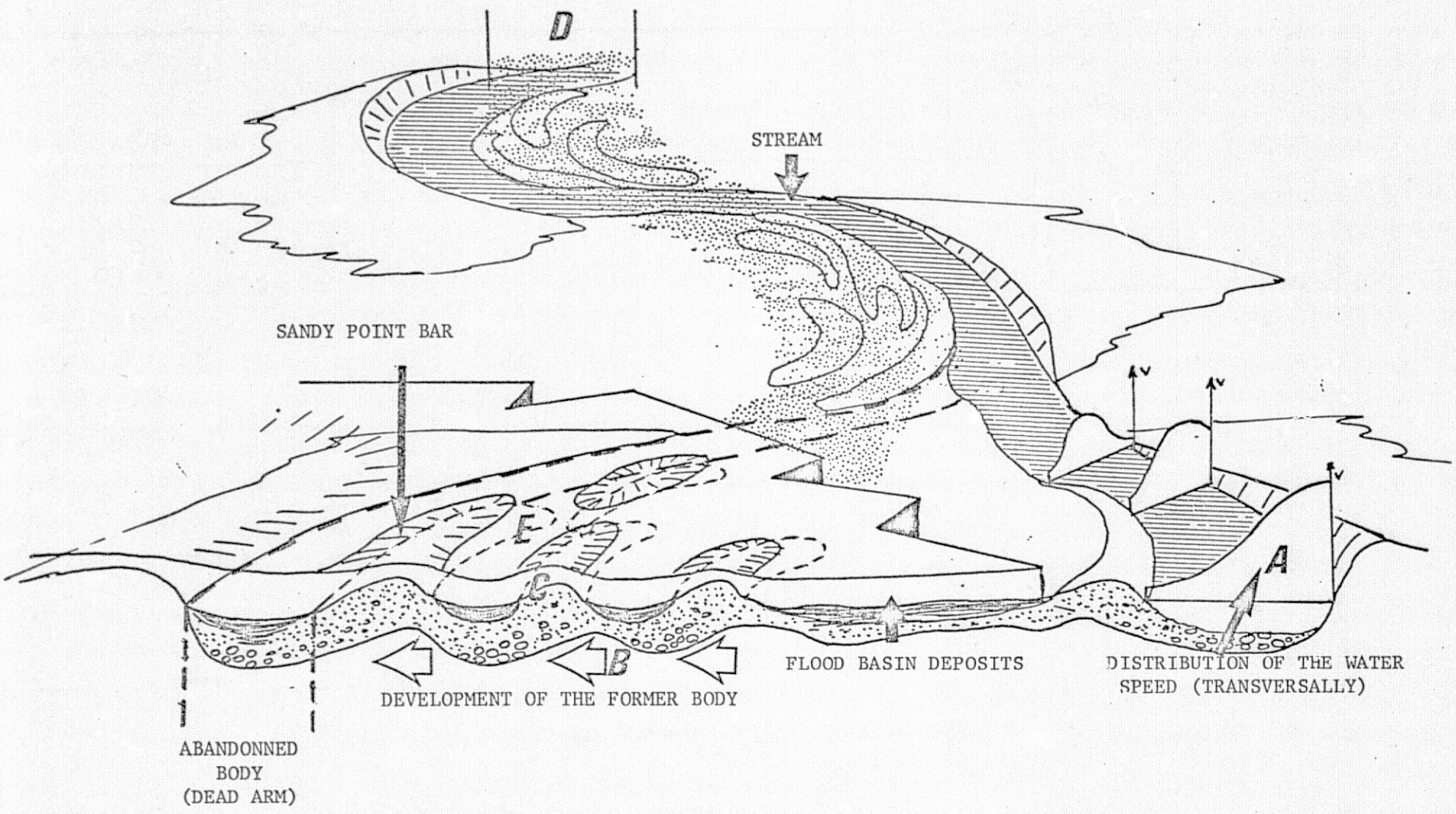


FIGURE 1

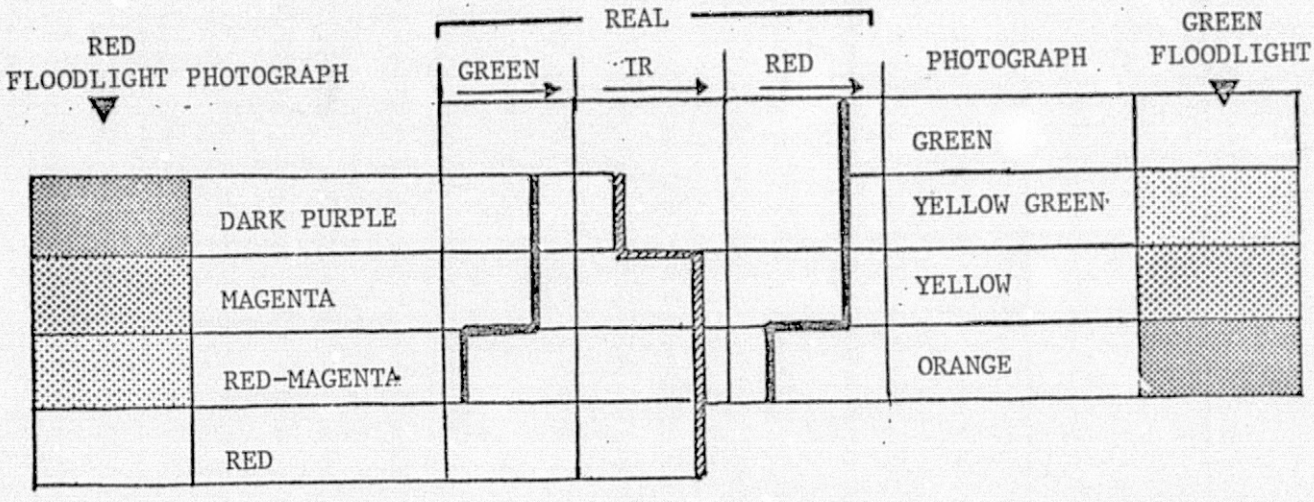


FIGURE 2

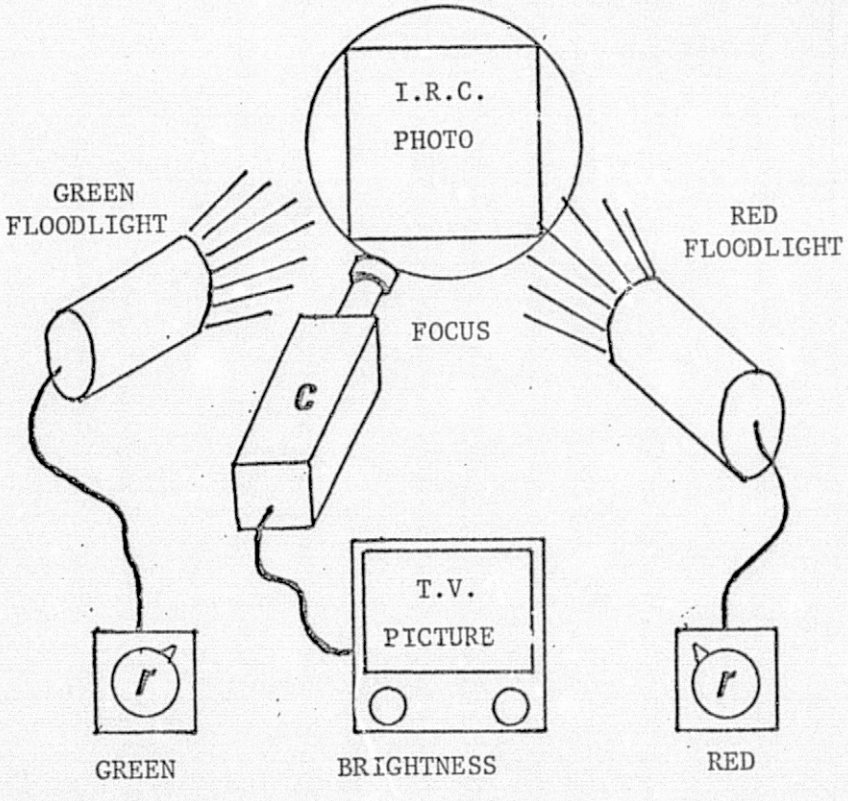


FIGURE 3

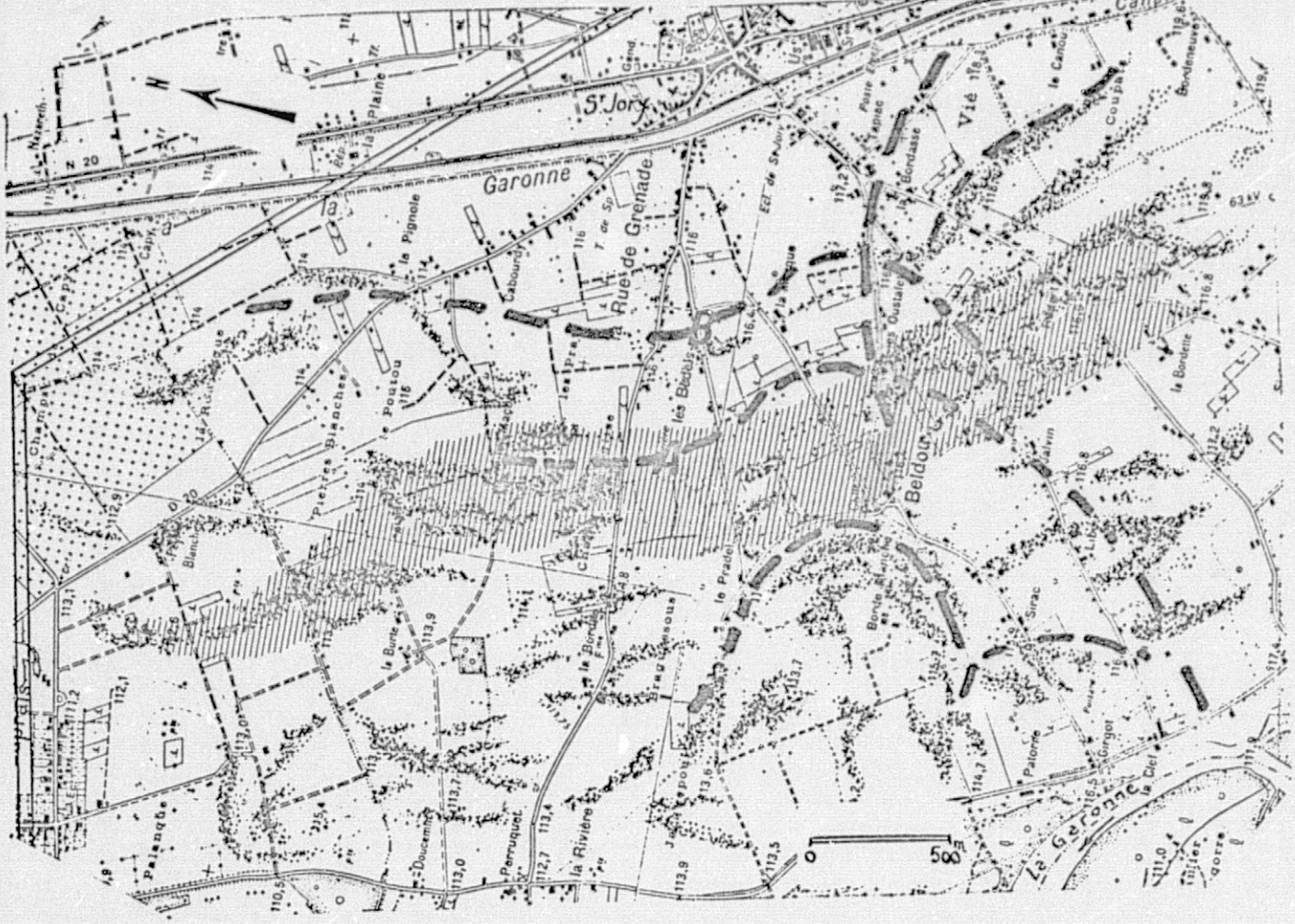


FIGURE 4

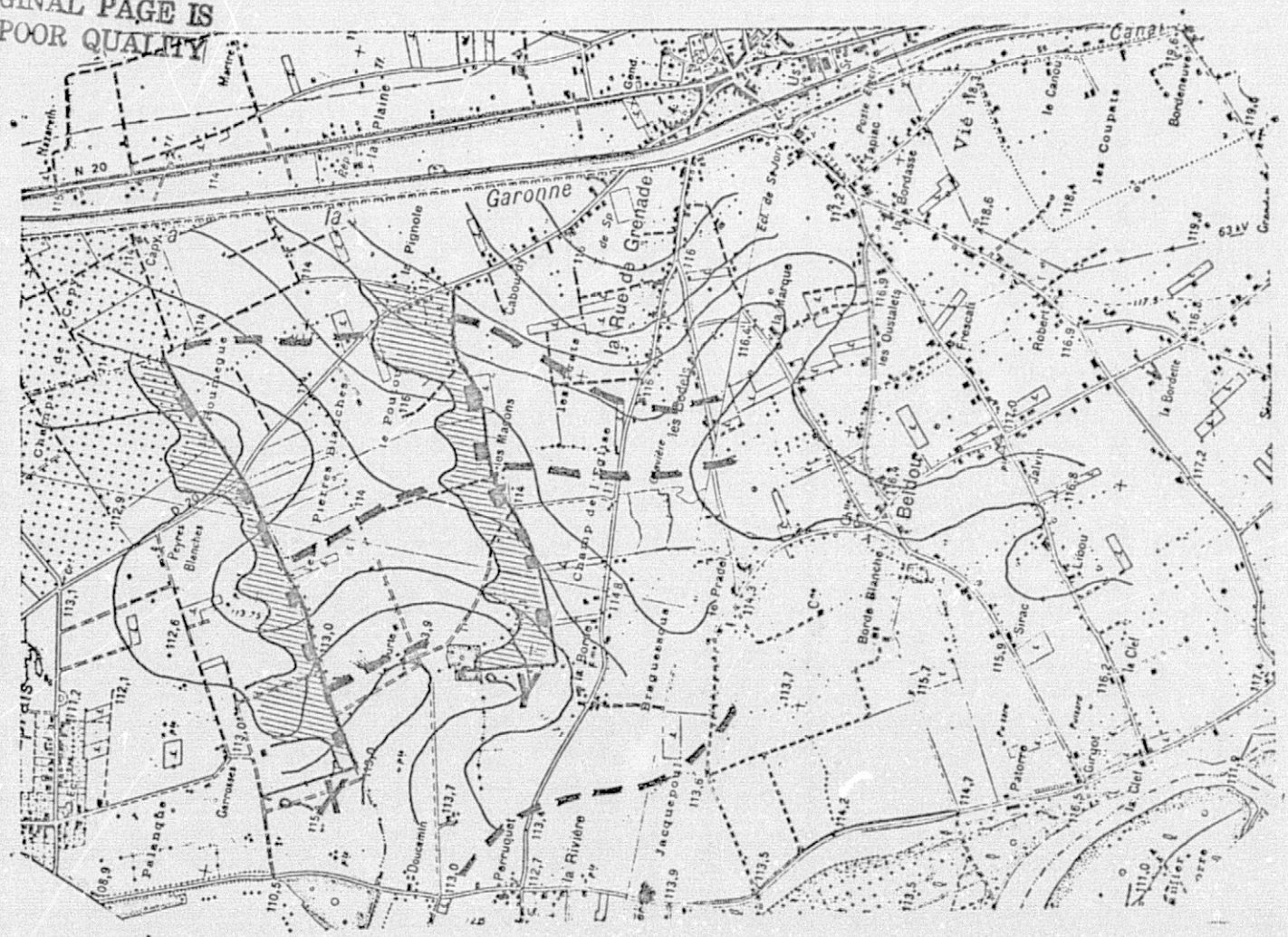


FIGURE 5

CHAPTER 3

A PRELIMINARY THEORITICAL STUDY IN ORDER TO ESTIMATE BY REMOTE SENSING THE BIOMASS IN A POPLAR SITE

G. FLOUZAT

Abstract : In this text, the theoritical approach to the study of the yield of poplar wood consists in determining the accuracy of the microdensitometric method of processing the aerial images of poplar sites.

A reminder and a presentation of the active parameters show that it is the study of structures that should be undertaken rather than the study of the reflectance of the plantations.

A theoritical simulation model has been given along with an example of its application. Later, we will add to the report of the AGRESTE experiment the results of the thorought application of this model.

This experimentation allows us to envisage a useful application of the data obtained. In an initial stage, the correlations with the ground biometric measures will indicate the efficiency of Remote sensing from a plane at a low altitude for the measurement of the workable part of biomass. At a second stage, the application of these results in a larger number of plots spreadover the whole site will increase the density of information of the ground-truth.

The knowledge thus acquired of the region under study will serve us as a reference stick in judging the efficiency of the different systems when the resolution has diminished. A 1/20 000 map will thus be established and the data transmitted by the multispectral scanners (the aircraft Daedalus ; Landsat 2, MSS) will be compared.

CESR : Centre d'Etude Spatiale des Rayonnements
TOULOUSE

I. ACTIVE PARAMETERS IN THE STUDY OF POPLAR SITE

The collation of parameters intervening in the measurement of the ratio of plantation cover gives the following list :

- Phenological stage of poplars
- Spectral identification of crowns
- Sun elevation on aerial survey time
- Age of the plantation or yield class
- Soil upkeep
- Plantation density
- Plantation mode
- Lopping of trees
- Resolution of remote sensing imagery
- Resolution of the analysis element of the imagery
- Angle between direction of tree lines - numerical scanning direction
- Varieties cultivated
- Soil water availability
- Presence and fluctuations of water table
- Chemical properties of soil.

This accurate statement shows the factors which have to be known before one can look for acorrelation with the measures of biometric characteristics in the plots to be sampled.

The influence of some of these parameters is eliminated or minimized by the conditions of the remote sensing process. This is true for the phenological stage, the position of the sun and the resolution of the image.

In fact, the flight which GDTA has been commissionned to do took place after total foliation has occured and at the time when the sun is at its highest in the region and at the apropriate date. The desired resolution corresponds in the films with the capacity of the photogrammetric camera in a photographic survey to the scale of 1/10 000.

The parameter "the age of the plantation or the yield class" will be studied using the correlations obtained between the factors resulting from the biometric characteristics and the measurement of the cover rate ; which constitutes the basis of the model.

We can then regroup the other active parameters into three factors :

a) the conditions of plantation and upkeep

b) the soil fertility

c) the type of image processing

In order to ascertain the influence of the first and third factor, a theoritical study was carried out before the aerial photographic data were obtained.

II. SIMULATION OF THE MEASUREMENT OF COVER RATE

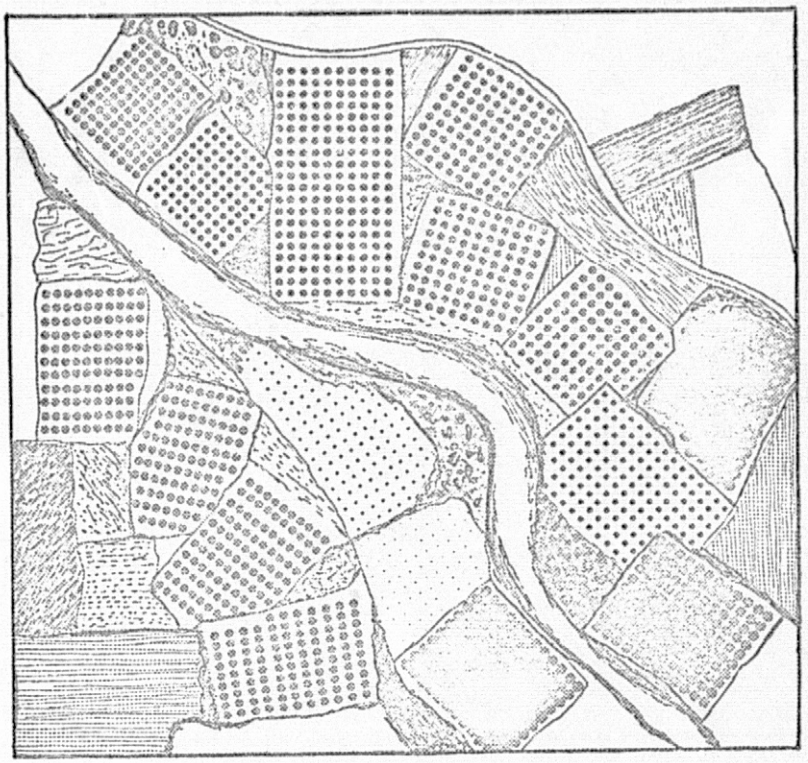
It was particularly important therefore to know the accuracy of the measurement of the cover rate in the conditions selected for the image processing. This information constitutes in fact the only physical link with the biometric characteristics :

- Diameter breast height
- Basal area
- Basis girth
- Total height
- Cutting height
- Volume of wood cubic content

For this, the theoritical model was built. It reproduces at a scale of 1/10 000 various plots where in most cases the crowns coïncide with circles.

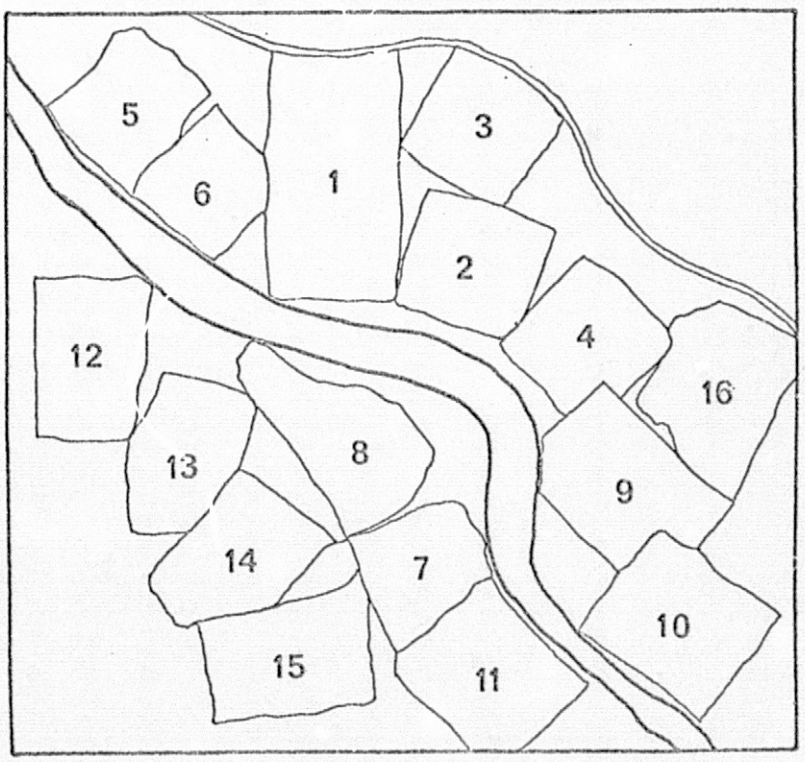
The figures on the next page show an enlargement (G = 2) of the model and the localization of the plots the characteristics of which are given in table I. A reading of this allows, to affirm that the conditions of plantation and upkeep are simulated.

This simulation was digitized with a step of 25 u by the micro-densitometer of the C.E.S.R. The availability of this numerical data obtained in "real dimension" allows one to study the role played by the image processing. In this report an example of an attempt to establish the accuracy of the measurement of cover rate is given for plot n° 1. A prerequisite of this analysis was the definition and the application of the process represented by the diagram (Software of C.E.S.R. data processing group). Two examples of intermediary stages are given in the figures "Display of plots n° 1, 5 and 6" and "Histogram of plot n° 1.



Theoritical model used

(Simulated scale : 1/5 000)



Localization of plots

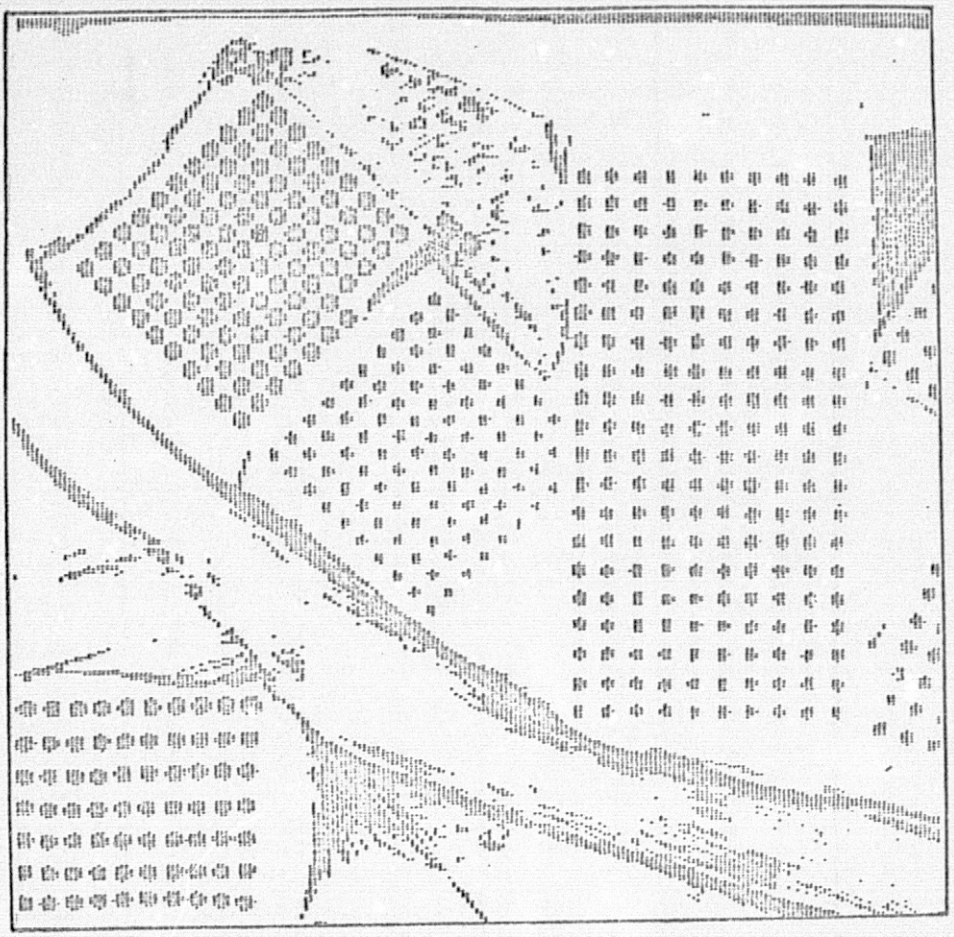
TABLE I - PLOT CHARACTERISTICS OF THE THEORITICAL MODEL

Plot number	Diameter	Crown girth	Crown area	Plantation	Density/ha ratio	Cover rate	Angle to the North	Observations
1	5,00	15,70 m	19,63 m2	7 x 7 m	204	40,0 %	0°	
2	5,00	15,70 m	19,63 m2	7 x 7 m	204	40,0 %	19°	
3	5,00	15,70 m	19,63 m2	7 x 7 m	204	40,0 %	34°	
4	5,00	15,70 m	19,63 m2	7 x 7 m	204	40,0 %	45°	
5	5,00	15,70 m	19,63 m2	6 x 6 m	278	60,1 %	45°	
6	4,28	13,43 m	14,38 m2	6 x 6 m	278	39,9 %	45°	
7	1	3,14 m	0,78 m2	7 x 7 m	204	1,6 %	45°	
8	2	6,28 m	3,14 m2	7 x 7 m	204	6,4 %	45°	
9	3,5	10,99 m	9,61 m2	7 x 7 m	204	19,6 %	45°	
10	6,75	21,19 m	35,76 m2	7 x 7 m	204	72,9 %	45°	Irregular crowns
11	6,75	21,19 m	35,76 m2	7 x 7 m	204	72,9 %	45°	Grass cover
12	5,00	15,70 m	19,63 m2	6 x 8 m	208	40,8 %	0°	
13	5,00	15,70 m	19,63 m2	6 x 8 m	208	40,8 %	15°E	
14	5,00	15,70 m	19,63 m2	6 x 8 m	208	40,8 %	40°E	
15	5,00	15,70 m	19,63 m2	6 x 8 m	208	40,8 %	80°E	
16	8,00	25,12 m	50,24 m2	7 x 7 m	204	91,9 %	45°	

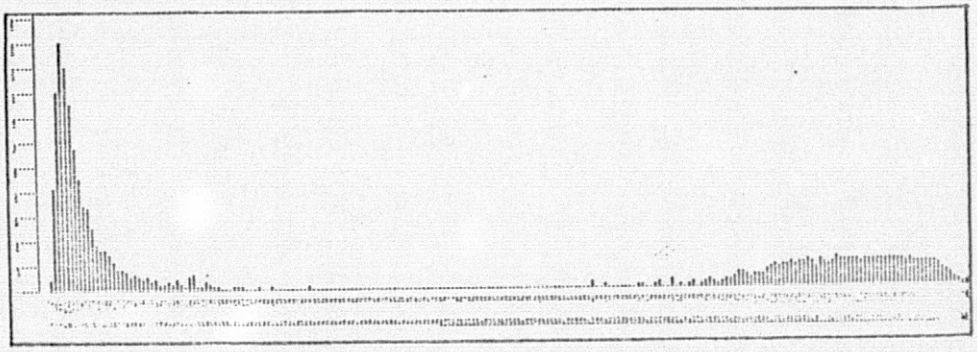
A series of element analysis taken on plot n° 1 and carried out in accordance with the procedure of the diagram is expressed on the table II

TABLE II - ANALYSIS ON PLOT N° 1

Histogram element	O.D. Crowns	Total number of points	Average	Cover rate
1	7 026	17 545	88,15	40,3 %
2	14 067	34 485	97,59	40,0 %
3	28 859	68 365	97,56	42,0 %
4	5 315	12 769	89,38	41,6 %
5	66 359	163 823	90,71	40,5 %
6	5 375	12 769	95,10	42,0 %
7	6 172	15 399	108,25	40,0 %
8	5 503	13 221	97,69	41,6 %
9	5 494	12 656	94,85	43,4 %
10	3 031	7 688	88,85	40,4 %
11	3 082	7 688	88,57	40,0 %
12	3 018	7 688	92,86	40,8 %
13	3 369	7 688	103,61	43,8 %
14	10 690	25 538		41,8 %
15	10 997	25 877		42,4 %
16	6 249	15 976		39,1 %
17	6 451	15 976		40,3 %
18	11 547	26 168		40,9 %
19	11 648	28 620		40,7 %

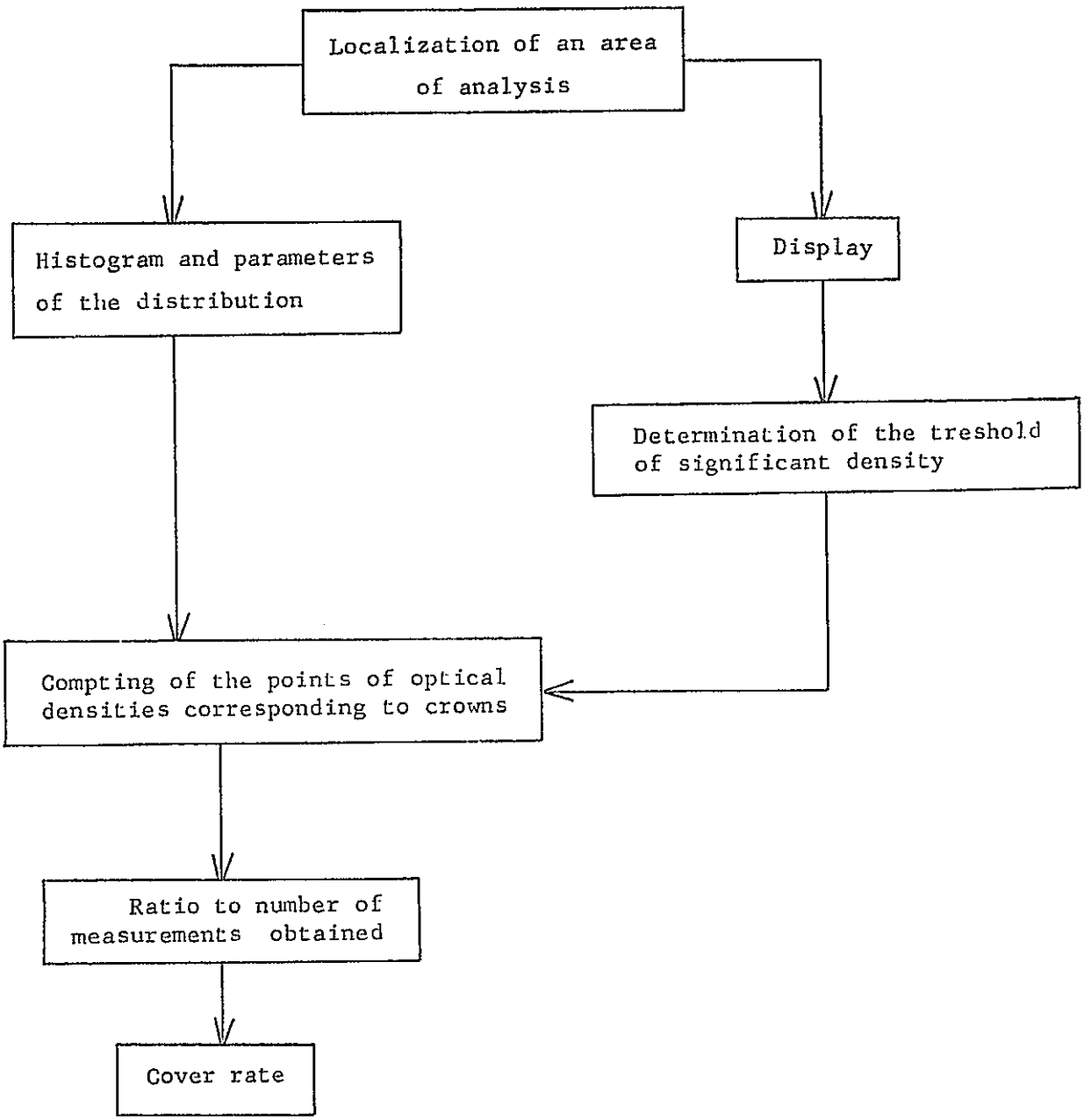


Display of theoritical plots, n° 1, 5 and 6



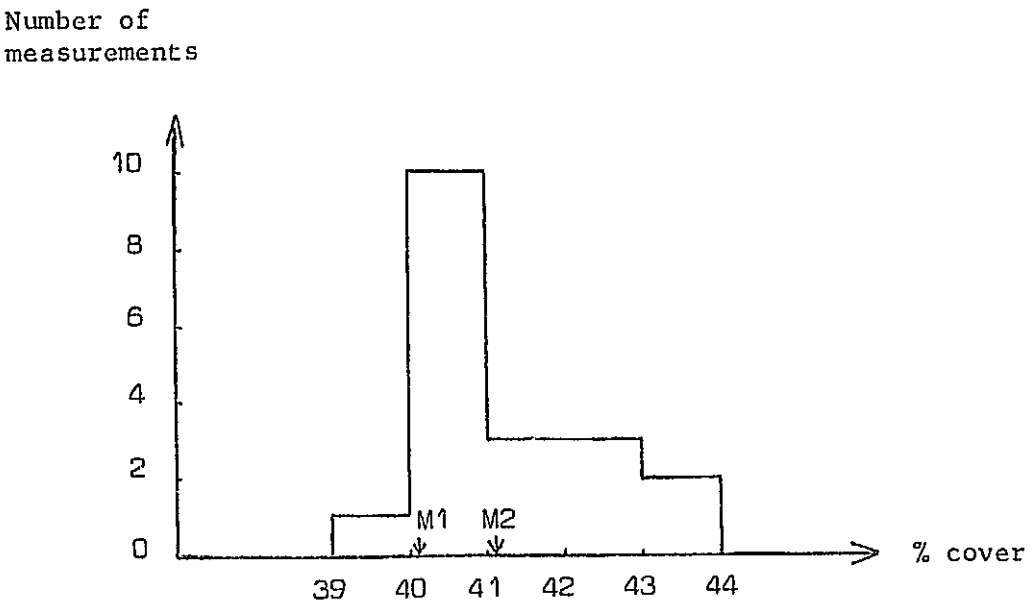
Histogram of plot n° 1

DIAGRAM OF MODEL ANALYSIS



The distribution of these measurements of cover rate are represented in the fig. "Distribution of the measurements of the cover rate". This simulation presumes that the parameter "spectral discrimination of the crowns" is really known. This calls for a special study on significant pass-bands in this kind of remote sensing.

Distribution of the measurements of cover rate



M1 = 40,1 : Cover rate of the model

M2 = 41,1 : Average of cover rate measured

The difference between M1 and M2 is satisfactory and allows one to presume that measurements on aircraft data will be accurate enough to be applied in the model.

However, one notices a general shift in the measurements in comparison with the real value. This is due to the size of analysis element. The sides of the squares or rectangles in which the histogram is effected are slightly inferior to the distance between two lines of plantations. Thus, this increases the ratio givingthe cover rate. In order to obtain values which are closer the reality, one must use surface elements the sides of which are exactly proportional to the spacing of the plants.

This theoritical study will thus allow an appreciation of the influence of the parameters which are directly linked to the processing of data obtained by remote sensing as regard the study of poplar sites. It has the added interest of revealing all the factors which play a part in this attempt to simulation.

This has been made easier by undertaking a first inventory of poplar plantations all over the middle Garonne area (about 50 kms from Toulouse to Castelsarrazin). This map is at the scale of 1/20ooo and obtained by photointerpretation from I.G.N. aerial photographical missions of 1969 and 1971 (panchromatic emulsions). This document was elaborated by including subdivisionsin the plots where the growth of the plants is not homogeneous.

This work will enable us to tackle the problems of biomass estimation in favorable conditions.

CHAPTER 4

PREMIERE PARTIE DE LA CARTOGRAPHIE DES PEUPLERAIES DE LA MOYENNE VALLEE DE LA GARONNE

(Test-site n°5 du Programme AGRESTE)

G. FLOUZAT

Résumé :

La première partie de la carte des peupleraies de la moyenne vallée de la Garonne est présentée à son échelle originale (E = 1/20 000). Ensuite, le programme d'utilisation de cette carte et des photographies infra-rouge couleur est décrit. Les phases successives doivent amener une connaissance du site directement utilisable et une référence pour le traitement des données acquises par les autres moyens de télédétection sur le même site.

I - CARTOGRAPHIE DES PEUPLIERS

La carte des peupliers a été réalisée par deux photointerprétations successives :

- en 1974, la première utilisait des photographies panchromatiques (échelle : 1/25 000) des missions de l'Institut Géographique National (I.G.N.) (Montauban 1969 ; Toulouse-Ouest 1971).
- en Décembre 1975, la seconde utilisait dès leur disponibilité les photographies infra-rouge couleur (échelle 1/10 000) du Groupement pour le développement de la Télédétection Aérospatiale (G.D.T.A.) (Mission "peupliers de la Garonne" du 01 - 05 - 1975).

CESR : Centre d'Etude Spatiale des Rayonnements
TOULOUSE

Cette interprétation touche uniquement les peupliers et ne représente pas les autres formations boisées. La zone cartographiée couvre la vallée de la Garonne sur une vingtaine de kilomètres. Les quatre sections de carte nécessaires correspondent au tiers de l'ensemble du test-site n° 5 du programme AGRESTE.

Le critère de photointerprétation est celui défini par l'Instituto per la Sperimentazione alla Pioppicultura" avec quatre classes de recouvrement :

Classe 1 : 0 à 5 %
Classe 2 : 5 à 25 %
Classe 3 : 25 à 75 %
Classe 4 : + de 75 %

Cet inventaire répertorie 451 parcelles de peupliers dont la répartition est donnée en II - 1.

Une observation a été faite en comparant les photointerprétations des missions 1969 - 1971 et 1975 : elle fait apparaître que nombre de peupleraies exploitées depuis 1971 n'ont pas été replantées en 1975.

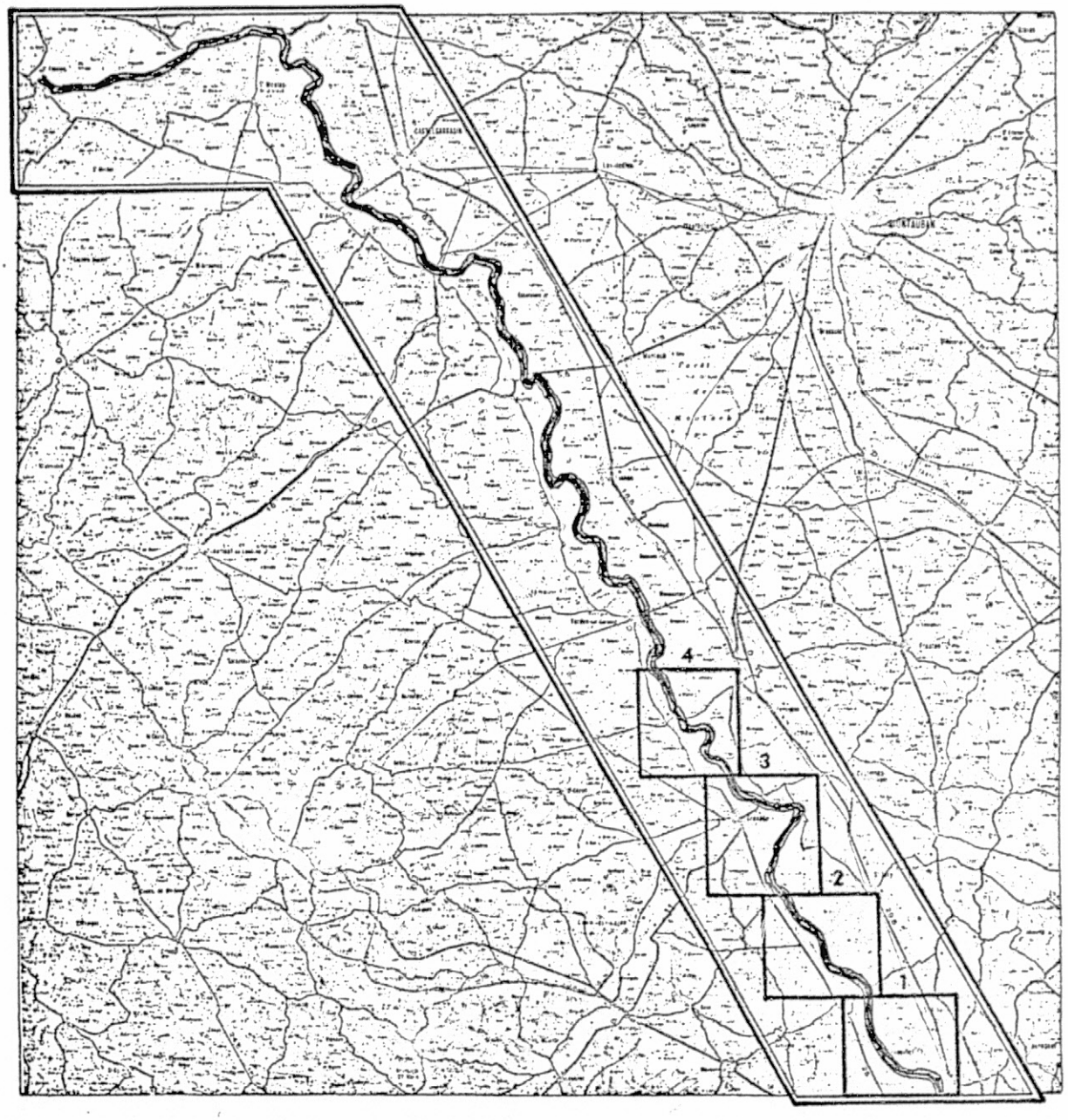
Les pages suivantes présentent la position des quatre sections de carte par rapport à l'ensemble du test-site, puis chacune de ces sections à l'échelle originale (1/20 000).

LOCALISATION DU SITE N° 5

DU PROGRAMME AGRESTE

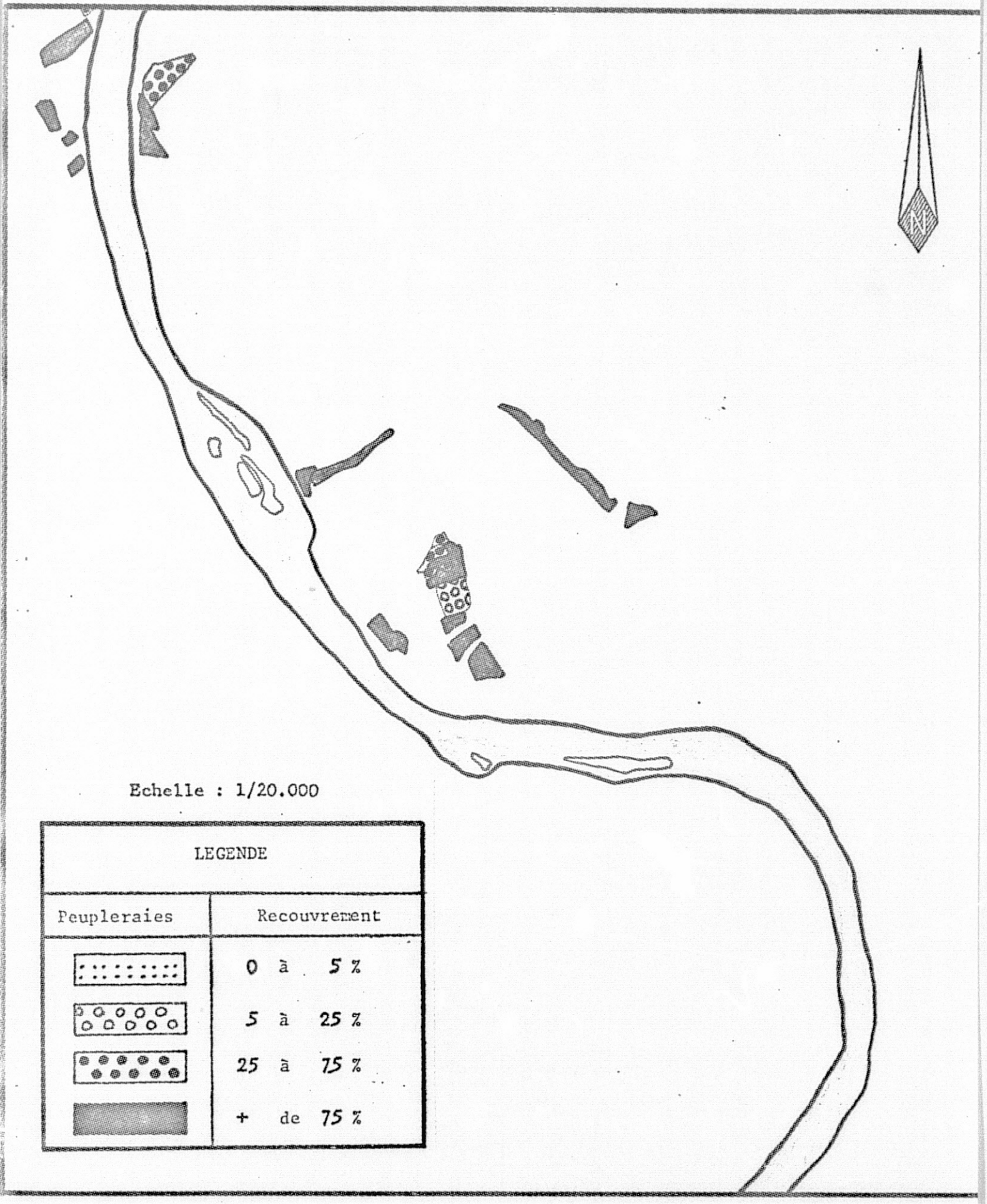
ET DE LA PREMIERE PARTIE DE LA CARTOGRAPHIE

DES PEUPLERAIES



Le trait double délimite la région étudiée (Moyenne Vallée de la Garonne) et les rectangles correspondants aux quatre sections cartographiées.

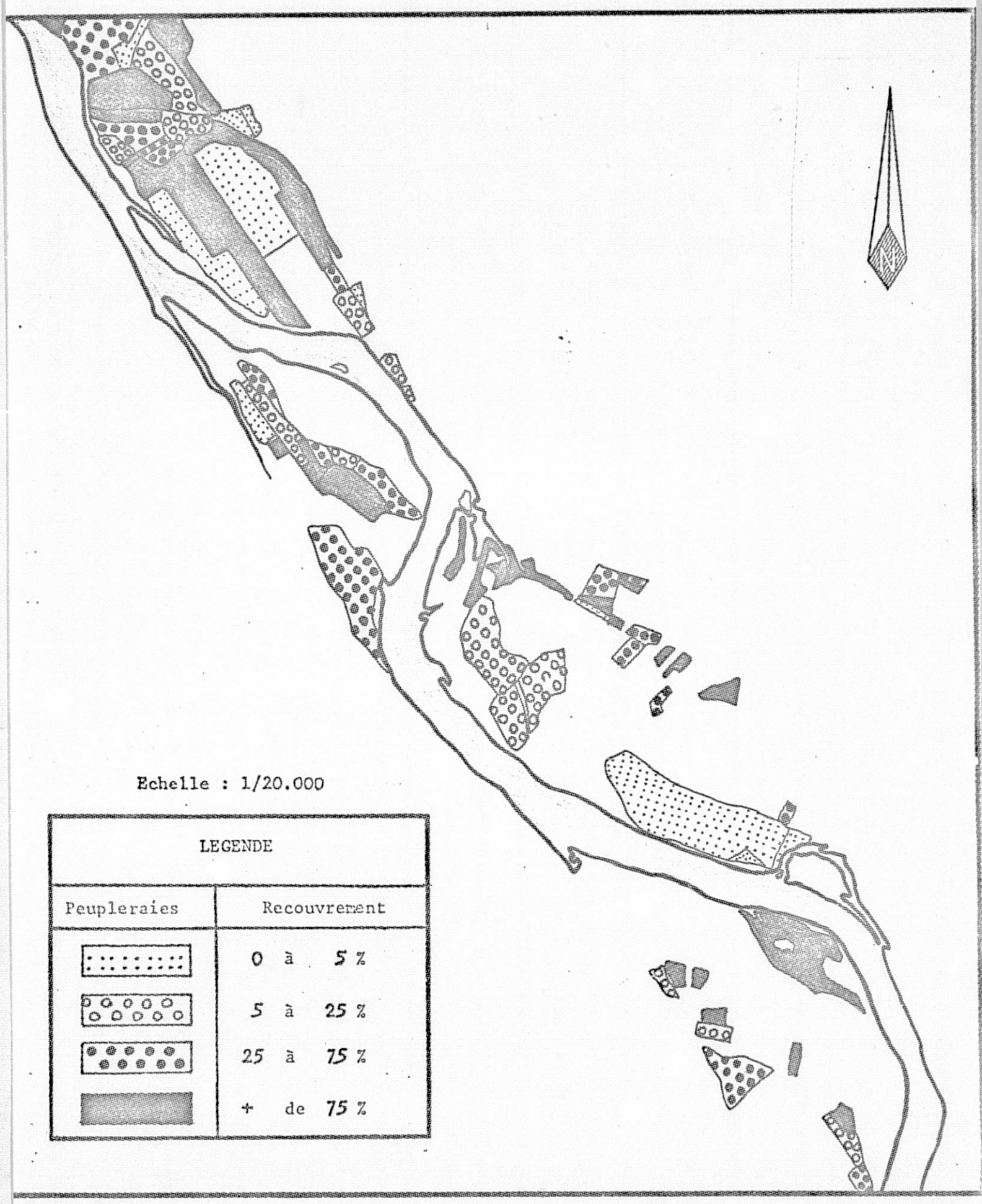
SECTION 1



Echelle : 1/20.000

LEGENDE	
Peupleraies	Recouvrement
	0 à 5 %
	5 à 25 %
	25 à 75 %
	+ de 75 %

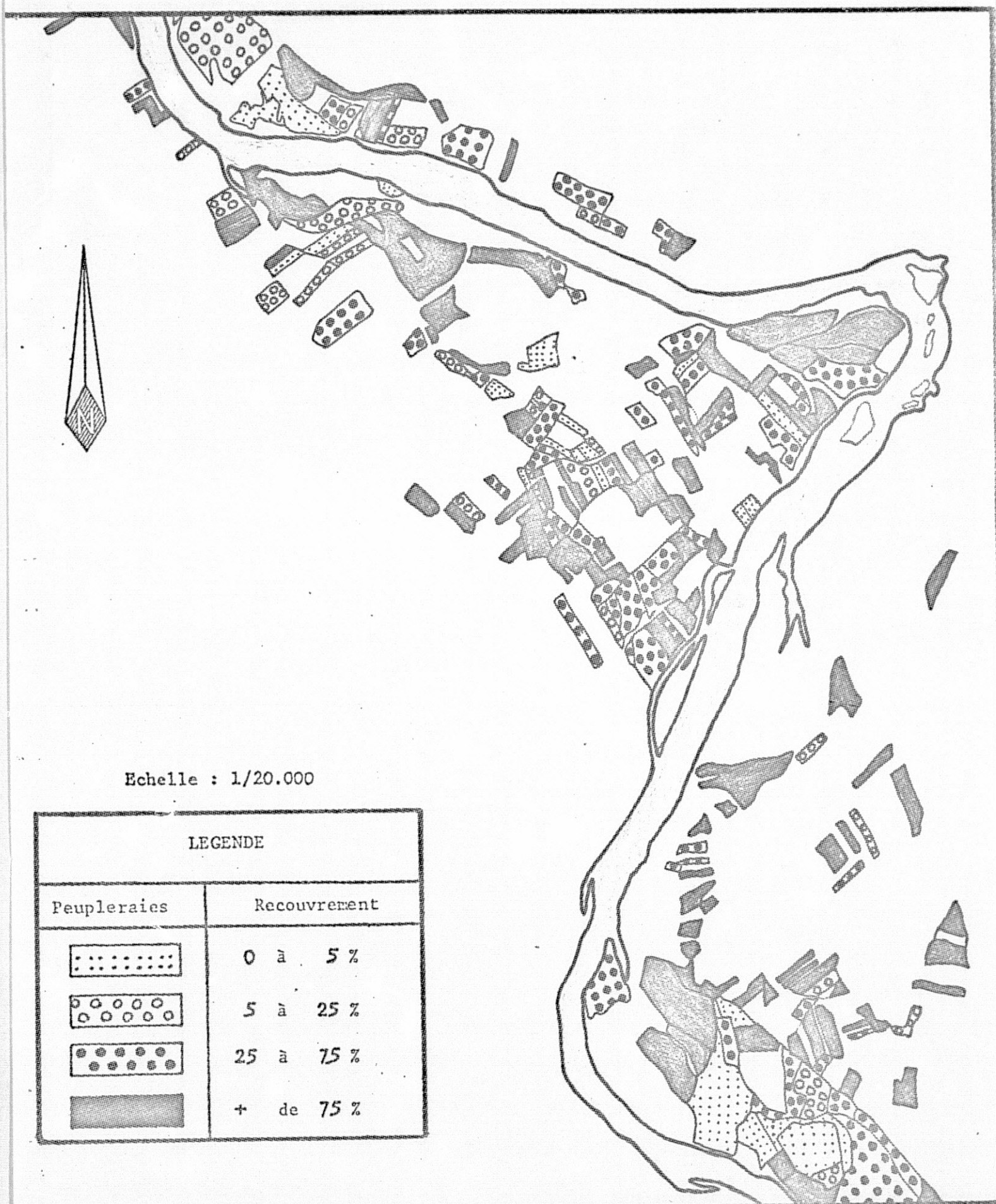
SECTION 2



Echelle : 1/20.000

LEGENDE	
Peupleraies	Recouvrement
	0 à 5 %
	5 à 25 %
	25 à 75 %
	+ de 75 %

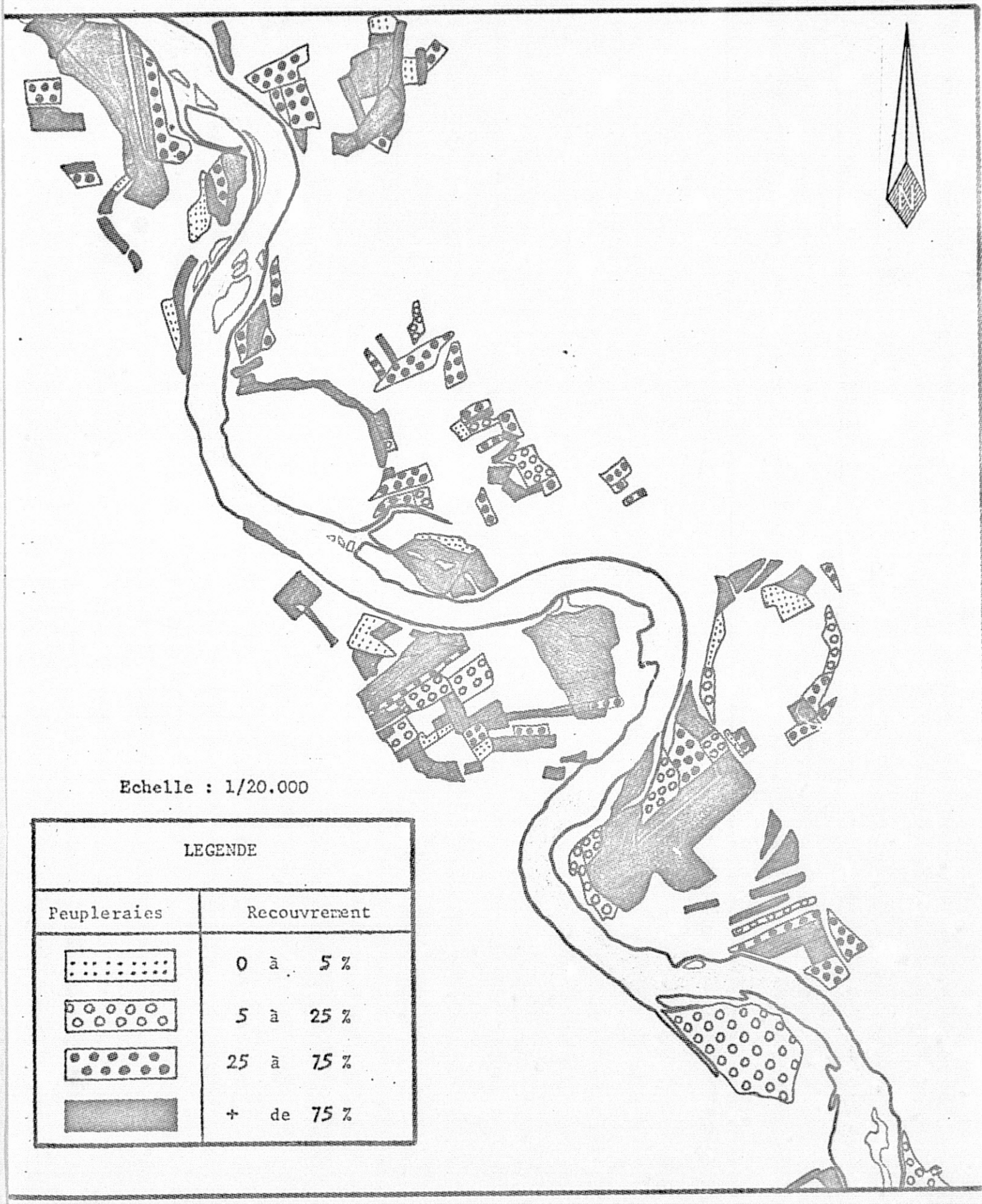
SECTION 3



Echelle : 1/20.000

LEGENDE	
Peupleraies	Recouvrement
	0 à 5 %
	5 à 25 %
	25 à 75 %
	+ de 75 %

SECTION 4



Echelle : 1/20.000

LEGENDE	
Peupleraies	Recouvrement
	0 à 5 %
	5 à 25 %
	25 à 75 %
	+ de 75 %

II - PROGRAMME D'UTILISATION DE LA CARTE ET DES DONNES IRC.

L'acquisition de cette vérité-terrain a deux buts :

a)- connaître l'état actuel de la culture du peuplier dans cette région

b)- disposer d'une référence permettant une comparaison avec les informations apportées par d'autres capteurs de télédetection et ainsi, connaître leurs limites respectives dans ce type d'expérimentation.

1. Résultat immédiat et première conclusion

La répartition des 541 parcelles répertoriées est donnée dans le tableau suivant :

Nombre de parcelles

Classes / Sections	1	2	3	4
1	0	1	3	14
2	10	14	17	27
3	22	24	50	97
4	13	15	37	87

Ce comptage sera suivi dans une prochaine phase de la mesure des surfaces occupées par chaque classe de recouvrement.

Pour toutes les parcelles, le résultat est le suivant :

Classes	1	2	3	4
Nombre de parcelles	55	64	107	225
Taux	12%	14%	23%	50%

Ce tableau entraine une première conclusion relative à la prévision globale de production de bois de peuplier dans cette région.

Bien que la mesure des surfaces coorespondantes ne soit pas encore faite définitivement, il semble qu'il y ait une baisse très nette de la plantation du peuplier au cours des dernières années. Il est donc probable qu'il y aura une baisse de la production de bois de peuplier dans cette zone lorsque la classe 2 et la classe 1 actuelles seront en âge d'être exploitées.

2. Echantillonnage et mesures de terrain.

Ces opérations ont pour but d'apporter les informations nécessaires à l'établissement de relations entre la structure du "toit" des peupleraies et leur volume de bois. Elles s'appuient donc sur une conception qui ne fait pas appel à la mesure d'une réflectance. L'utilisation des photographies infra-rouge couleur est justifiée dans ce cas par la résolution spatiale qu'elles fournissent.

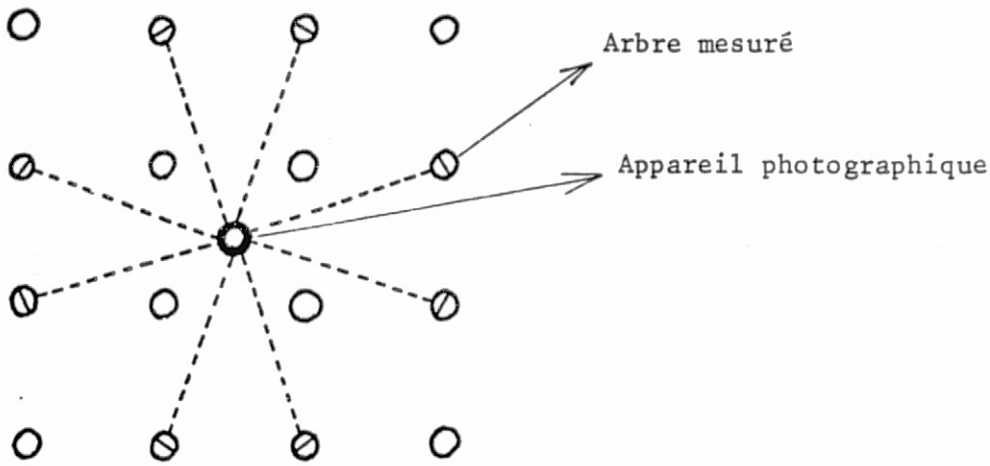
Ainsi, les caractéristiques de cette détection, simulées théoriquement montrent que la technique d'étude du taux de couverture donne une mesure à $\pm$ 3 % près. Or, la période significative de l'accroissement du recouvrement se situe entre 5 et 80 %.

Ces deux conditions de travail font que la méthode d'analyse microdensitométrique des peupliers permet de distinguer un nombre de classes suffisant pour la corrélation avec les stades de croissance interessants.

Ces stades seront échantillonnés selon les critères suivants :

- homogenéité des parcelles
- représentativité et complémentarité en âge des plantations
- distance au point central de la photographie servant à l'analyse n'introduisant pas de distorsion.

Les levés biométriques seront effectuées sur les peupleraies retenues. La technique utilisée sera la photographie hémisphérique où huit mesures sont significatives dans chaque prise de vue.



Disposition des 8 arbres étudiés

Pour un arbre, les mesures suivantes sont effectuées sur la photographie :

- surface terrière (avec une part de contrôle au sol)
- hauteur à la découpe
- cubage par billons

A cela s'ajoute la mesure au sol de la surface basale.

Les plantations étant homogènes, trois prises de vues suffiront pour définir le volume moyen des arbres de la plantation étudiée. (Soient 24 mesures par parcelle).

Ce procédé implique un plan de charge opérationnel fixant le nombre de parcelles à retenir vers 50. Cinquante mesures moyennes seront donc tirées de 1 200 cubages. Cet échantillonnage affectera ainsi 11 % des peupleraies de cette partie de la carte.

3. Exploitation

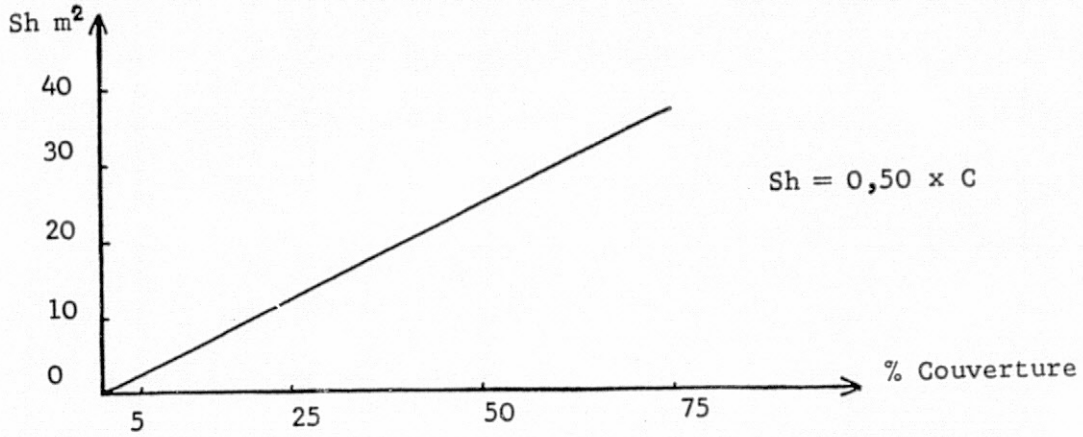
Ces données levées sur le terrain seront ensuite mises en relation avec les mesures des taux de couverture des mêmes parcelles par microdensitométrie. Cette mesure fournira la surface du houppier vue à la verticale. Cette surface est dépendante des conditions de plantation. Trois cas principaux sont représentés dans la moyenne vallée de la Garonne :

- Plantation "carrée" : 7m x 7m (204 plants/ha)
- Plantation "carrée" : 6m x 6m (278 plants/ha)
- Plantation "rectangulaire" : 6m x 8m (208 plants/ha)

Les trois graphiques suivants donnent les relations taux de couverture-surface du houppier vu à la verticale.

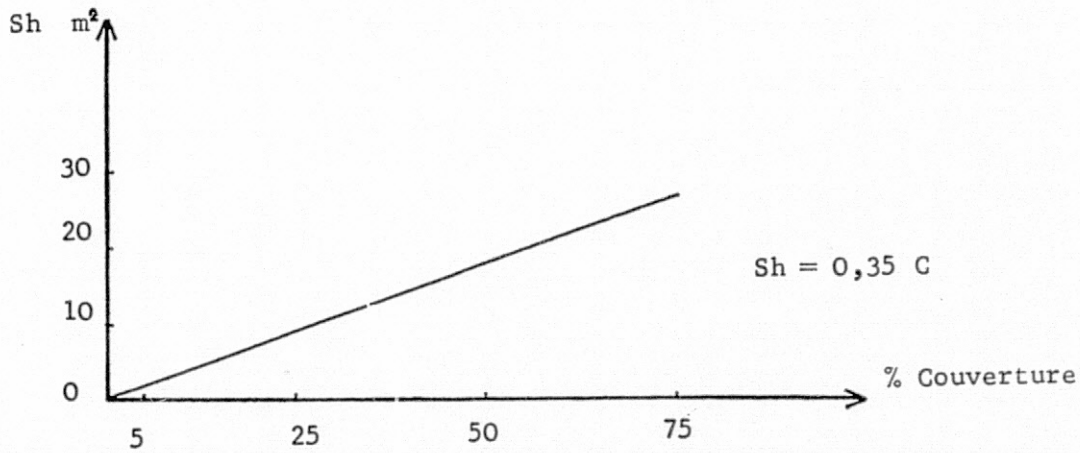
Relation Taux de couverture - Surface du houppier pour une plantation 7 x 7m :

Surface du houppier



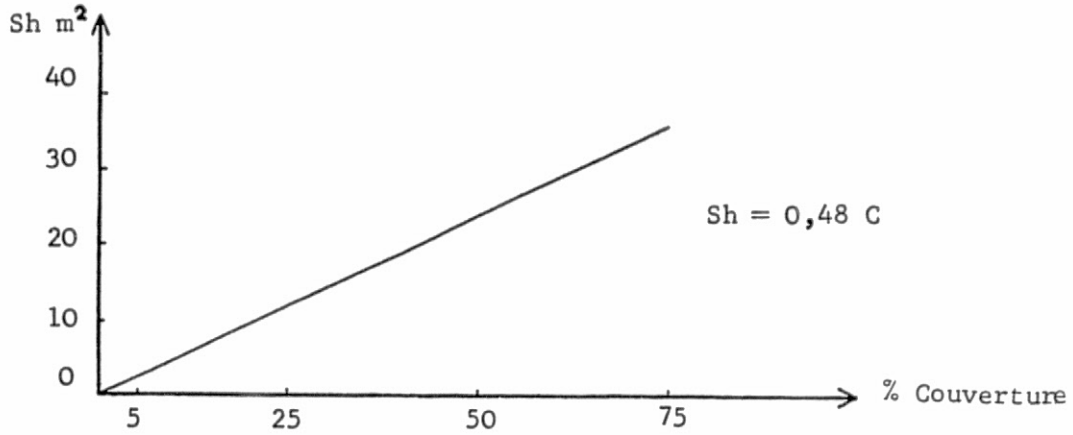
Relation Taux de couverture - Surface du houppier pour une plantation 6 X 6m :

Surface du houppier



Relation Taux de couverture - Surface du houppier pour une plantation 6 x 8m :

Surface du houppier



L'obtention de cette mesure du houppier servira à la recherche des lois reliant :

Taux de couverture à Surface terrière

Taux de couverture à Volume de bois

Les mesures au sol s'ajoutant aux correlations éventuelles entre mesures de télédetection et mesures de terrain, deux types de résultats sont à espérer :

Une table Surface terrière / Volume de bois

Une table Taux de couverture / Surface terrière

Il va de soi que l'échantillonnage de base est conçu dans des conditions écologiques homogènes pour éliminer les perturbations dues à des croissances de physionomies différentes.

A l'établissement des deux tables, s'ajoutera la relation entre le volume de bois exploitable et l'âge de la plantation puisque cette information sera collectée au cours de l'étude des parcelles échantillonnées. Ceci devait conduire aux deux connaissances suivantes :

- évolution de l'accroissement annuel d'une peupleraie (l'âge donnant la fonction du temps)

- prévision de la production disponible d'une zône (la carte fournissant la mesure de surface)

Dans le cadre de ces opérations d'utilisation de la Carte des Peupleraies et des données IRC, des échantillonnages différents entrepris ultérieurement seraient souhaitables pour juger de la variation des tables en fonction des conditions pédologiques d'installation des plantations.

CHAPTER 5

COMPARAISON ET PREMIERE INTERPRETATION DE DIFFERENTES DONNES DE TELEDETECTION SUR UNE MEME ZONE DE PEUPLERAIES

G. FLOUZAT (CESR) et J. DAGNAC (SCV)

Résumé : Un bilan des données disponibles pour la réalisation de l'objectif "Peupliers" du programme Agreste dans la Vallée de la Garonne montre que l'information utilisable efficacement est contenu dans un petit nombre de scènes.
La date tardive de réception de ces données n'interdit pas de faire une comparaison entre les images obtenues aux différents niveaux de télédétection. L'interprétation fournit alors une récapitulation des renseignements que l'on peut obtenir de chaque type de document.

1 - DONNES DISPONIBLES ET DONNES COMPAREES

Les données disponibles pour l'étude du site n° 5 du programme Agreste sont indiquées dans le tableau de la page suivante. Elles représentent la quasi-totalité de l'information et les différentes conditions d'acquisition. Pourtant, le volume de traîtement nécessaire dans cet objectif est limité. En effet, deux scènes Landsat 2 d'excellente qualité représentent toute l'imagerie intéressante à petite échelle.

CESR : Centre d'Etude Spatiale des Rayonnements
TOULOUSE
SCV : Service de la Carte de la Végétation
TOULOUSE

TABLEAU DES DONNEES DISPONIBLES

Véhicules capteurs	Date	Altitude	Bandes	Résolution	Scènes du Site n°5	Qualité	Observations
Landsat 2 MSS	02-06-75	910 Km	0,5-0,6 µ	80 m	1/3 Nord	Mauvaise - Nuages	
"	19-06	"		"	2/3 Sud	Moyenne - Qq nuages	
"	20-06	"		"	1/4 Sud	Bonne	
"	07-07	"	0,6-0,7 µ	"	2/3 Sud	Nuage-Site utilisable	Bande magnétique demandée
"	08-07	"		"	2/3 Sud	Mauvaise - Nuages	
"	26-07	"	0,7-0,8 µ	"	1/2 Nord	Bonne	
"	26-07	"		"	3/4 Sud	Bonne	Bande magnétique demandée
"	06-10	"		"	Site entier	Bonne	
"	06-10	"	0,8-1,1 µ	"	1/10 Sud	Nuage-Site utilisable	
Daedalus MSS	01-05	1 500 m	10 canaux*	4 m	Site entier	Bonne	Bandes numériques possibles sur les zones interessantes
IRC Photo.	01-05	1 500 m	0,55-0,80	25 cm	Site entier	Bonne	

* Bandes passantes du Scanner Daedalus : 0,38-0,42 ; 0,42-0,45 ; 0,45-0,50 ; 0,50- 0,55 ; 0,55-0,60 ; 0,60-0,65 ; 0,65-0,70 ; 0,70-0,80 ; 0,80-0,90 ; 0,90-1,10µ.

Les autres données (imagerie à grande échelle : MSS Daedalus, Photographie IRC) dont le traîtement est nécessaire sont également en quantité raisonnable puisqu'un échantillonnage régional éliminera les zones redondantes.

Une partie cartographiée du site n° 5 a été choisie pour présenter un exemple de comparaison d'images à des altitudes très dissemblables (sections 3 et 4 de la carte au 1/20 000).

Les documents retenus sont les suivants :

- Carte des peupliers dans la partie Sud n° 5
  (réduite à l'échelle : 1/100 000)
- Réduction d'un assemblage noir et blanc des photographies infra-rouge couleur. (Echelle : 1/100 000)
- Réduction d'une visualisation de données Daedalus.
  (Echelle : 1/100 000)
- Agrandissement de la région cartographiée avec une scène Landsat 2. (Echelle : 1/100 000)

L'utilisation dans une première interprétation et la préparation de ces montages aboutissent à la description des apports respectifs des principaux types de télététection. (Les bandes passantes choisies sont équivalentes).

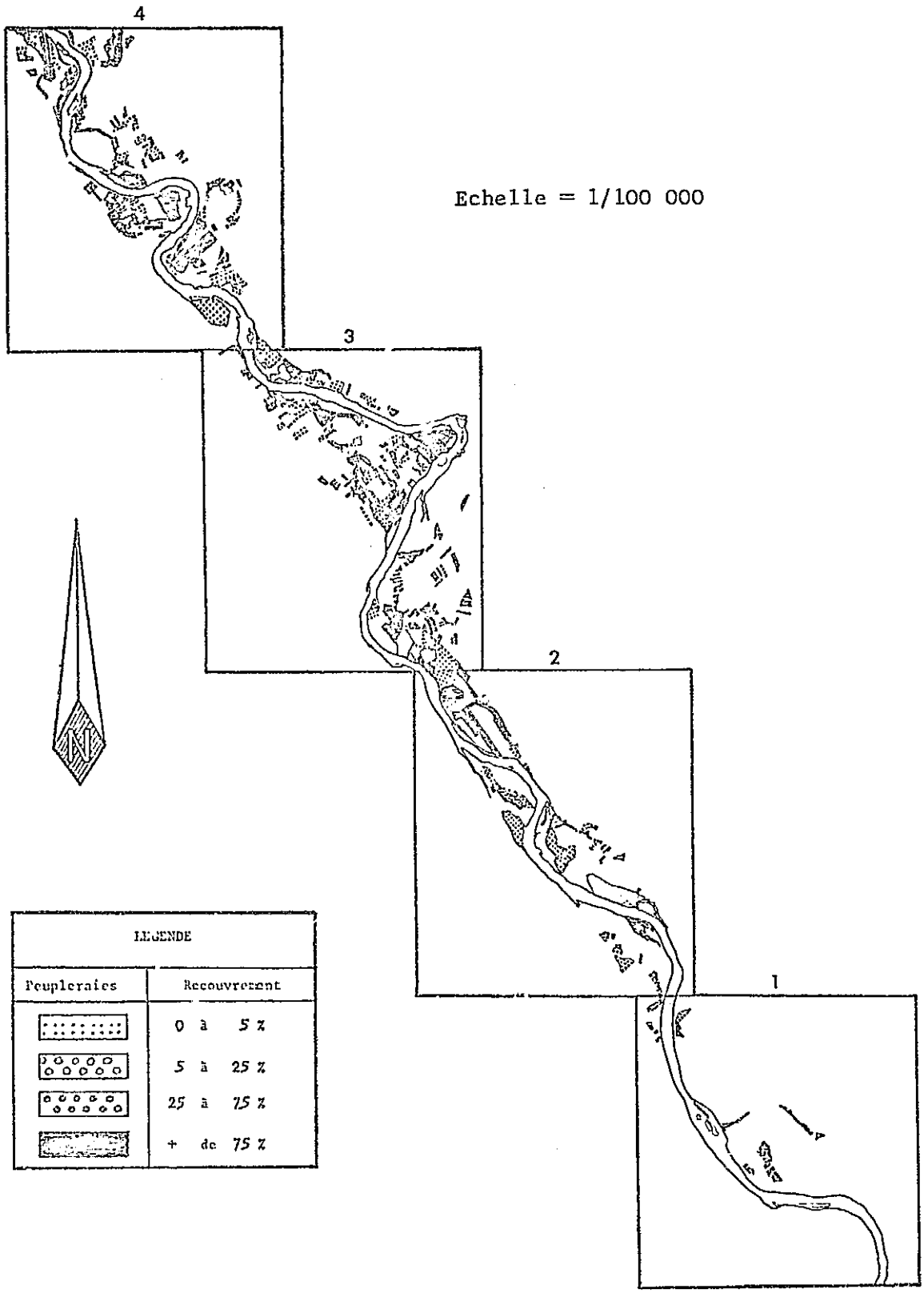
II - APPORTS RESPECTIFS DES TROIS CAPTEURS

1. Photographies infra-rouge couleur

La mission aérophotographique au 1/10 000 réalisée avait pour but de fournir un inventaire détaillé des peupleraies. Les caractéristiques de résolution des images obtenues ont donc donné lieu à une cartographie des surfaces occupées par quatre classes d'âge. Les rapports entre les différentes classes d'âge pour établir une prévision et les conditions d'exécution en sont fournies au chapitre précédent : "Première partie de la cartographie des Peupleraies de la moyenne vallée de la Garonne". Une réduction de cette carte au 1/100 000 est présentée comme référence pour aider à la comparaison globale des images des différents capteurs.

CARTE DES PEUPLIERS DANS LA PARTIE SUD

DU SITE AGRESTE N° 5



Les photographies infra-rouge couleur apportent d'autres renseignements :

- Caractéristiques du type de plantations
- Extension de la zone de faible distorsion
- Etat et entretien du sol
- Etat de feuillaison
- Taux de couverture.

REDUCTION D'UN ASSEMBLAGE NOIR ET BLANC DES PHOTOGRAPHIES INFRA-ROUGE COULEUR SUR LES SECTIONS 3 ET 4

Echelle : 1/100 000

- Caractéristiques du type de plantation.

Les mesures photogrammétriques permettent, après le calcul précis de l'échelle, de caractériser la peupleraie par :

le mode de plantation : carré ou rectangulaire

les distance entre les lignes de plantation

la densité de plantation.

Ainsi, le calcul du taux de couverture peut être fait en tenant compte de ces paramètres pour exprimer la surface du houppier.

- Extension de la zone de faible distorsion.

l'examen stéréoscopique des photographies indique jusqu'à quelle distance du nadir la distorsion ne risque pas d'entrainer une erreur dans la mesure du taux de couverture. En effet, lorsque cette distance augmente, la mesure de la surface des houppiers est faussée par l'introduction dans le recouvrement de point appartenant à des peupliers vus "de profil" ou en perspective. La zone de faible distorsion doit donc indiquer les lieux où les arbres sont photographiés "verticalement".

- Etat et entretien du sol.

La présence ou l'absence d'un tapis herbacée dans une plantation de peupliers revêt une grande importance dans les peupleraies jeunes. C'est dans ces classes que la confusion entre la couronne de l'arbre et la végétation au sol risque de nuire le plus à la détermination du taux de couverture. Dans des plantations plus agées, le recouvrement devient plus grand et l'erreur sur sa mesure diminue en même temps que la faible partie de sol visible à la verticale se réduit et se trouve masquée par les ombres des peupliers.

Les photographies infra-rouge couleur indiquent nettement l'état du sol. Il est donc possible de connaître les parcelles où les les mesures des houppiers devront être contrôlées.

- Etat de feuillaison.

La date de la mission aérophotographique est le 1er mai 1975. Dans les conditions bioclimatiques du début de cette année 1975, les peupliers n'ont pas toujours une feuillaison complète. Il est ainsi possible de distinguer 3 stades d'avancement de cette phase phénologique :

débourrage

feuillaison moyenne

feuillaison complète.

Il apparait généralement sur les photographies que ces différents stades ne sont pas présents dans une même parcelle. Dans quelques cas, il a été constaté qu'ils permettaient de distinguer deux variétés très proches dans l'espace. Une étude est donc entreprise pour vérifier ou détruire l'hypothèse que ces stades d'avancement de la feuillaison correspondent à des différences variétales ou clonales des peupliers.

- Taux de couverture.

L'échelle des photographies (1/10 000) a été définie en fonction des enseignements tirés de l'analyse de la maquette théorique dont un exemple est donné dans ce rapport au chapitre "A preliminary th eoritical study in order to estimate by remote sensing the biomass in a poplar site".

L'analyse microdensitométrique du recouvrement sera donc appliquée aux peupleraies dans des conditions méthodologiques connues. De plus, la définition des caractéristiques du type de plantation fournit les paramètres nécessaires pour indiquer la surface du houppier en fonction du taux de couverture. Enfin, il faut noter que la résolution spatiale du film infra-rouge couleur aérien utilisé est voisin du pas de digitalisation de l'image (25 cm).

2. Radiomètre à balayage Daedalus

Une couverture aérienne à basse altitude sur la moyenne vallée de la Garonne a été réalisée le 1er mai 1975 par le radiomètre à balayage Daedalus puisque celui-ci était embarqué dans le même avion que

la caméra Wild chargée avec le film infra-rouge couleur. La comparaison des deux réductions au 1/100 000 des assemblages IRC et Daedalus montre une résolution spatiale plus faible du radiomètre (environ 3 m).

REDUCTION D'UNE VISUALISATION DE DONNEES DAEDALUS

SUR LES SECTIONS 3 ET 4

Echelle : 1/100 000

Canal 7 : 0,65 - 0,70 u

Canal 10 : 0,90 - 1,10 u

Par ailleurs, il semble que plusieurs canaux combinés ne permettent pas forcément de discriminer les peupleraies. L'identification par la reconnaissance de structure est aléatoire du fait de la valeur du rapport objet/résolution spatiale. La discrimination multispectrale ne lève pas toujours l'ambiguité par rapport aux formations boisées appartenant au cortège floristique des associations hygrophiles et les autres plantations (fruitières) sont également difficiles à séparer.

Dans les jeunes peupleraies, l'importance de l'etat et de l'entretien du sol est primordiale. Lorsque le sol est nu, la résolution est telle que la petite taille du houppier ne modifie pratiquement pas la réponse qu'enregistre le radiomètre. Lorsque le sol est couvert d'un tapis herbacé, le radiomètre reçoit une energie correspondant à un toit continu de végétation. Dans les deux cas, les classes d'age jeunes sont affectées par erreur, soit au sol nu, soit à des classes plus agées.

Il faut donc s'attendre à des difficultés dans l'utilisatio des classifications multispectrales pour la discrimination des peupleraies.

Cependant, les données numériques du radiomètre à balayage Daedalus seront du plus grand intérêt lorsqu'il deviendra intéressant d'étudier la perte d'information en fonction de la dégradation de la résolution spatiale. Cette opération, qu'il est prévu de mener conjointement avec une analyse identique sur la maquette théorique, pourrait apporter d'utiles renseignements sur la signification de l'information contenue dans les données LANDSAT 2 dont la résolution est de 80 m.

3. Radiomètre à balayage LANSAT 2

Les données du scanner multispectral du satellite LANDSAT 2 fournissent des informations à petite échelle, conformes à ce que laissait supposer la mission Daedalus.

Ainsi, la discrimination ne semble pas pouvoir séparer les différentes formations boisées (Peupliers, Fruitiers, bois du bord des eaux) Par contre, l'identification des cultures et de l'hydrographie est efficace.

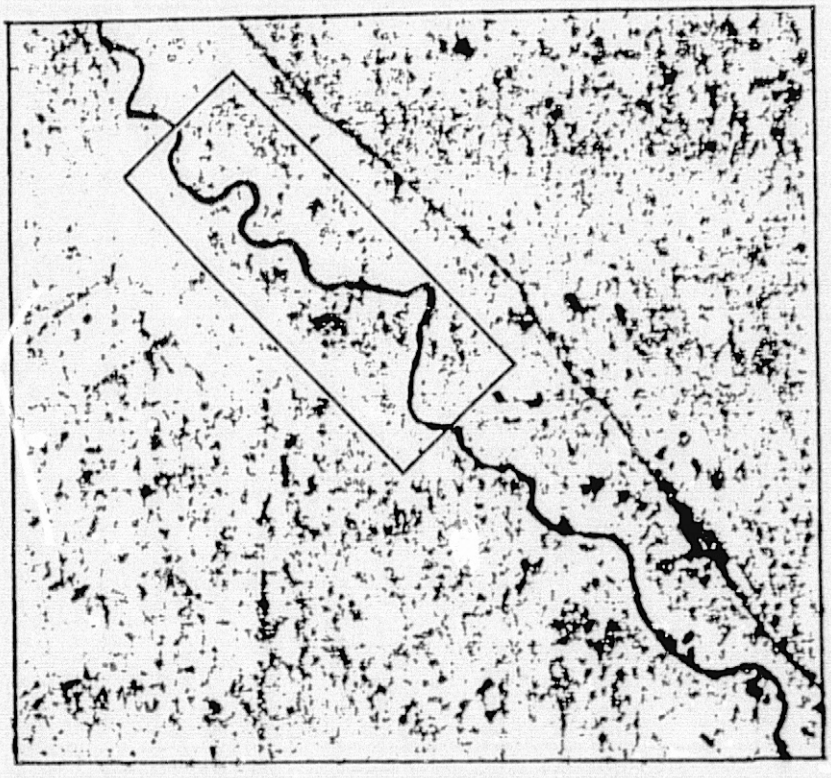
Un renseignement interessant est obtenu dans cette imageri grâce à la vue synthétique que procure l'observation à haute altitude et la faible résolution : il s'agit de la délimitation par photointerprétation

AGRANDISSEMENTS DE LA REGION CARTOGRAPHIEE

DU SITE " PEUPLIERS - GARONNE "

(Scène LANDSAT 2 du 07 - 07 - 1975 ; E = 1/200 000)

Canal 5 : 0,6 - 0,7 µ

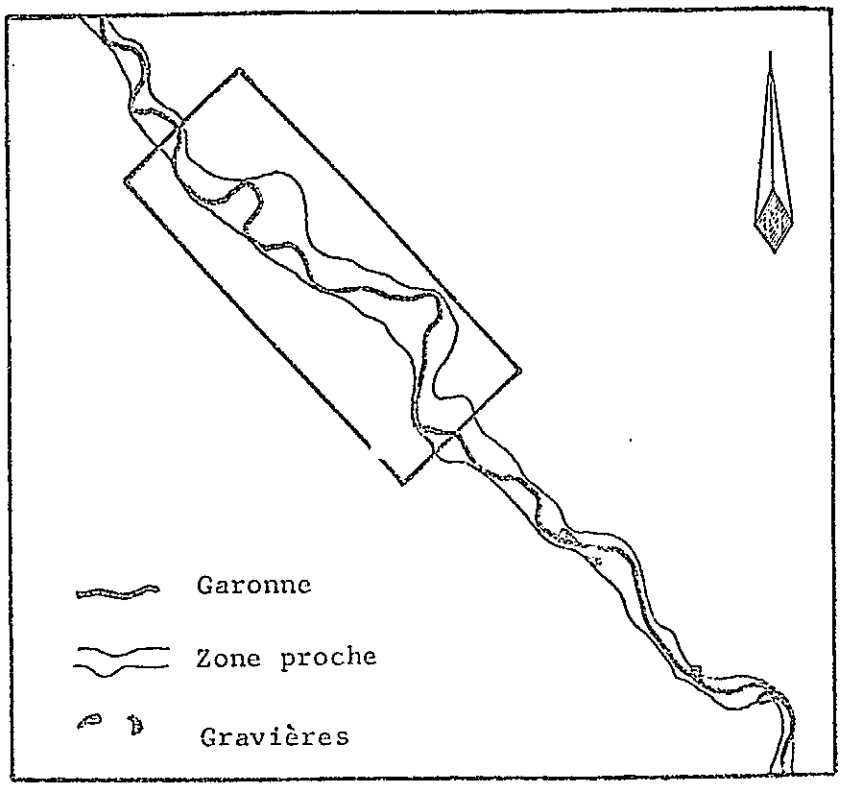


Canal 7 : 0,8 - 1,1 µ

de la zone proche de la Garonne contenant la quasi-totalité des formations boisées de la vallée. (Un exemple de cette cartographie est donné sur la partie cartographiée du site.) L'intérêt de cette information est qu'elle correspond vraisemblablement à la basse plaine. Cette zone est donc celle qui réunit les conditions écologiques optimales pour le peuplier.

CARTOGRAPHIE DE LA ZONE PROCHE DE LA GARONNE

CONTENANT LES FORMATIONS BOISEES DANS LES SECTIONS 3 ET 4



Cette donnée apporte ainsi la possibilité de mesurer le potentiel de production de la région par les peupleraies. En effet, cette zone est formée de différents éléments :

Peupleraies

Formations boisées naturelles

Fruitiers

Cultures et Prairies

Surfaces en eau (Garonne et gravières)

La surface totale de la zone est facile à connaître ainsi que l'ensemble des formations boisées et des surfaces en eau. La différence permet de connaître l'importance des cultures et des prairies.

Par la cartographie, les terres occupées par les peupleraies sont connues et indiquent la proportion qu'elles représentent par rapport à l'ensemble de la roue).

Deux types de potentiels de production seront ainsi définis :

1. La quantité de bois de peuplier que fournirait ce milieu si les plantations occupaient l'ensemble des surfaces boisées.
2. La quantité de bois de peuplier que fournirait ce milieu si les plantations occupaient les surfaces actuellement en peuplier et les surfaces en boisement naturel.

(L'hypothèse d'occupation des terres préalable à la définition de ce potentiel exclut l'installation du peuplier sur les terres utilisées actuellement par l'agriculture.)

En conclusion, le premier examen des différentes données sur une même zone de peupleraies fait apparaitre les possiblilités et les limites de chaque type de données. Ces résultats utilisables sont liés aux conditions de leur acquisition et montrent une certaine complémentarité.